

SECTION VI

OVERALL COST ASSESSMENT

This section develops and applies a methodology to estimate the cost of controlling pollution from urban storm-related discharges nationwide. Costs of controlling combined sewer overflows, stormwater runoff, and/or providing tertiary treatment are compared.

BACKGROUND

In 1967, the APWA conducted a survey to gain information related to wet-weather pollution.¹ All urban communities with a population greater than 25,000 persons were involved. Results indicated that approximately \$56 billion (1974 dollars) would be needed to complete separation of all existing combined sewers. An additional \$34 billion (1974 dollars) in plumbing changes on private property would be required to effect the separation. These costs do not include any indirect costs brought about by the disruption in a dense urban area which would occur if the separation actually took place.

In 1973 and 1974, USEPA conducted "Needs" surveys to estimate the costs to meet the requirements and goals set forth in the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). The surveys were sent to each state and, on the basis of the reported figures, a total cost was estimated. A review of the results of the surveys shows how little attention has been given to developing quantity and quality criteria by which the cost of controlling wet-weather pollution could be assessed.² Due to a lack of guidelines which the states could follow and the short time available, some states elected to use only USEPA guidelines. Those states that did make their own assessments went by their own criteria and are therefore not comparable on an equal basis. The reported needs for Category VI (Treatment and/or Control of Stormwater) of the 1974 Needs Survey were greater than the cost of all other categories combined. Reported costs included construction of storm sewers and elements of flood control.

The next part of this section presents a general methodology for determining wet-weather pollution control costs. Then, a procedure is described for determining the relationship between storage, treatment, and pollutant control for control of wet-weather flows. Generalized predictive equations are developed based on relatively intensive studies of five cities: Atlanta, Denver, Minneapolis, San Francisco, and Washington. Knowing this "production function" one can determine the optimal combination of storage and treatment by combining this information

with data on the cost and performance of the available control options. This information is combined to produce the national assessment. Results are presented for all

1. urbanized areas in the US,
2. states, and
3. USEPA regions.

METHODOLOGY

There are several economic theories which, when applied to environmental resources management, assist in the decision-making process. One such theory is production theory, which provides techniques that aid in evaluating items such as the optimal size of a reservoir for water supply and flood control, or a wastewater treatment plant for pollution control. When the cost of inputs such as the reservoir or treatment plant is known then the cost of achieving a desired level of output (e.g., water supply or pollution control) may be determined.

In stormwater management, the inputs may be in the form of a storage capacity and a treatment rate. Storage is expressed in terms of million gallons or inches over a certain area, typically the watershed being analyzed. The unit for treatment is either million gallons per day or inches per hour, using the same area as storage.

When the degree of wet-weather control is considered as a single output, it can be expressed either in terms of the percent of the runoff treated or the number of overflows per year. This is with respect to quantity only and is therefore dependent upon the input storage capacity and treatment rate.

When dealing with only two inputs it is feasible to use a graphical method to find the optimal combinations. Isoquants can be constructed which represent equal levels of output for different combinations of input (see Figure VI-1, Determination of Least-Cost Combination of Inputs). For example, each isoquant could represent a specific percent of the runoff treated for different combinations of storage and treatment. Isoquants have the following properties:³

1. Two isoquants cannot intersect. Intersecting isoquants would imply two different levels of output from the same input.
2. Isoquants slope downward and to the right because as one input increases it takes less of the other input to achieve the same level of output.

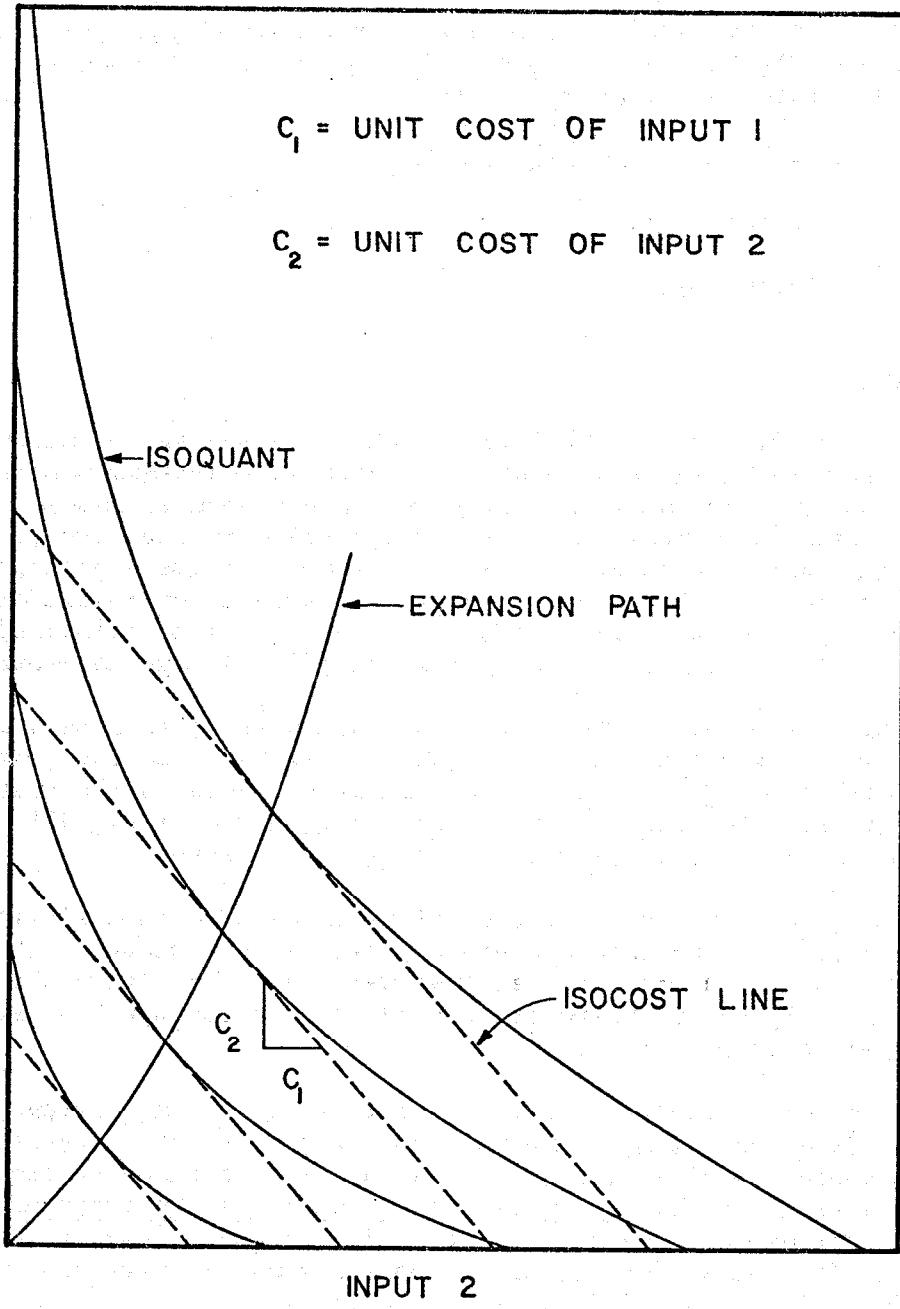


Figure VI-1. Determination of Least-Cost Combination of Inputs

3. Isoquants are convex to the origin because of the decreasing ability of one input to be substituted for another to obtain a given level of output. This is known as the principle of diminishing marginal rate of substitution.

Also on Figure VI-1, a series of parallel lines has been constructed. These lines represent combinations of input 1 and input 2 which may be achieved at the same total cost. The lines are known as isocost lines. The slope of the isocost lines is the relative unit cost between input 1 and input 2. The most economical combination of input 1 and input 2 to produce a desired level of output is the point where the isocost lines become tangent to the isoquant representing the desired level of output.

The line which joins the points of tangency among several isoquants and the isocost lines is called the expansion path. After the expansion path has been determined, the optimal combination of inputs can be determined for any level of output by finding the intersection of the isoquant representing the desired level of output and the expansion path.

The maximum output for a given cost may be found by constructing the isocost line for the given total expenditure. The slope of the isocost line is the relative unit cost of the two inputs. The intercept of the axis depicting input 1 would be the allowed total cost divided by the unit cost of input 1. From this information, the isocost line may be drawn. The point where the isocost line intersects the expansion path gives the combination of inputs which produces the maximum output at the given cost.

The stormwater quality management problem can be expressed in the more compact mathematical form shown below:

minimize

$$Z = c_S(S) + c_T(T) \quad (\text{VI-1})$$

subject to

$$f(R_1; S, T) = 0$$

$$R_1, S, T \geq 0$$

where Z = total control costs,

$c_S(S)$ = storage costs,

$c_T(T)$ = treatment costs,

S = storage volume,

T = treatment rate,

R_1 = percent pollutant control, and

$f(R_1; S, T)$ = production function relating the level of pollutant control (R_1) attainable with specified availabilities of storage (S) and treatment (T).

The next three subsections describe

- the available storage/treatment options - their costs and effectiveness;
- the production functions for evaluating tradeoffs between storage and treatment; and
- the solution to the optimization problem yielding the optimal expansion path for any city.

Given this information, the final assessment is presented.

CONTROL TECHNOLOGY AND ASSOCIATED COSTS

A wide variety of control alternatives are available for improving the quality of wet-weather flows.^{4,5,6} Rooftops and parking lot storage, surface and underground tanks and storage in treatment units are the flow attenuation control alternatives. Wet-weather quality control alternatives can be subdivided into two categories: primary devices and secondary devices. Primary devices take advantage of physical processes such as screening, settling and flotation. Secondary devices take advantage of biological processes and physical-chemical processes. These control devices are suitable for treating stormwater runoff as well as combined sewer overflows. However, the contact stabilization process is feasible only if the existing waste treatment plant is of an activated sludge type. The quantities of wet-weather flows that can be treated by this process are limited by the amount of excess activated sludge available from the dry-weather plant. At the present time, there are several installations throughout the US designed to evaluate the effectiveness of various primary and secondary devices. A summary of the design criteria and performance of these devices is presented in Table VI-1, Wet-Weather Treatment Plant Performance Data. Based on these data, the representative performance of primary devices is assumed to be 40 percent BOD_5 removal efficiency and that of secondary devices to be 85 percent BOD_5 removal efficiency.

Table VI-1. WET-WEATHER TREATMENT PLANT PERFORMANCE DATA

Device	Control Alternatives	Design Criteria gpm/sq ft (l/min-m ²)	Reported BOD ₅ Removal Efficiency, η
Primary	Swirl Concentrator ^{a,b}	60.0 (2,448.0)	0.25 - 0.50
	Microstrainer ^c	20.0 (816.0)	0.40 - 0.60
	Dissolved Air Flotation w/ Chemical Addition ^d	2.5 (102.0)	0.50 - 0.60
	Sedimentation ^e	0.5 (20.4)	0.25 - 0.40
Representative Performance			0.40
Secondary	Contact Stabilization ^f		0.75 - 0.88
	Physical-Chemical ^g		0.85 - 0.95
	Representative Performance		0.85

^aField, 1976.⁷

^bSullivan, 1974.⁸

^cMaher, 1974.⁹

^dLager and Smith, 1974.⁵

^ePerformance data based on domestic wastewater treatment.

^fAgnew et al., 1975.¹⁰

^gEstimate based on performance of these units for domestic wastewater.

"Storage" devices will typically be used in conjunction with the above "treatment" devices. The two purposes are interrelated. Wastewater detained a sufficient time in a storage unit will undergo treatment. On the other hand, treatment units also function as storage units in that they equalize fluctuations in influent flow and concentration. DiToro presents approaches for evaluating the equalization and treatment which occur in both of these units.¹¹ The STORM model, which was used in this assessment, assumes the configuration for storage and treatment shown in Figure VI-2, Storage-Treatment Configuration Used in STORM Model. No treatment is assumed to occur in storage and "treatment" is assumed to be complete removal of all pollutants routed through treatment. Thus, for the purposes of this assessment, no treatment is assumed to occur in storage and control costs are assigned accordingly. This assumption tends to underestimate the costs of storage since all provisions for solids handling are included in treatment.

Cost data for installed wet-weather treatment devices are listed in Table VI-2, Installed Costs for Wet-Weather Treatment Devices. Since wet-weather control facilities operate intermittently, annual operation and maintenance costs are greatly affected by the number of hours the facility is utilized. As a general rule, a facility will operate a greater amount of the time if it incorporates storage. An examination of Table VI-2 reveals that annual operation and maintenance costs are 16.7 percent of the total annual costs for the contact stabilization unit. In the case of the swirl concentrator, the percentage is 27.3. Annual operation and maintenance costs for other units fall in between these two values. Based on this analysis, it was decided to assume annual operation and maintenance costs as 20 percent of the total annual costs for all treatment devices. Cost functions developed for various wet-weather quality control devices are presented in Table VI-3, Cost Functions for Wet-Weather Control Devices. These costs include provisions for sludge handling, engineering, contingencies and land costs.

All treatment units exhibit economies of scale, i.e., unit costs decrease as plant size increases. Thus, there is an incentive to build larger units. The optimal size treatment unit can be found by comparing the savings in treatment cost of going to a larger unit with the increased piping costs. For example, if one is considering building two 10 mgd (37,850 m³/day) plants with building one 20 mgd (75,700 m³/day) plant and a pipeline, the breakeven pipe length, L, is found using

Two plants One plant + pipeline

$$s(10)^z + s(10)^z = s(20)^z + K(10)^y(L) \quad (VI-2)$$

where s, z, K and y = coefficients.

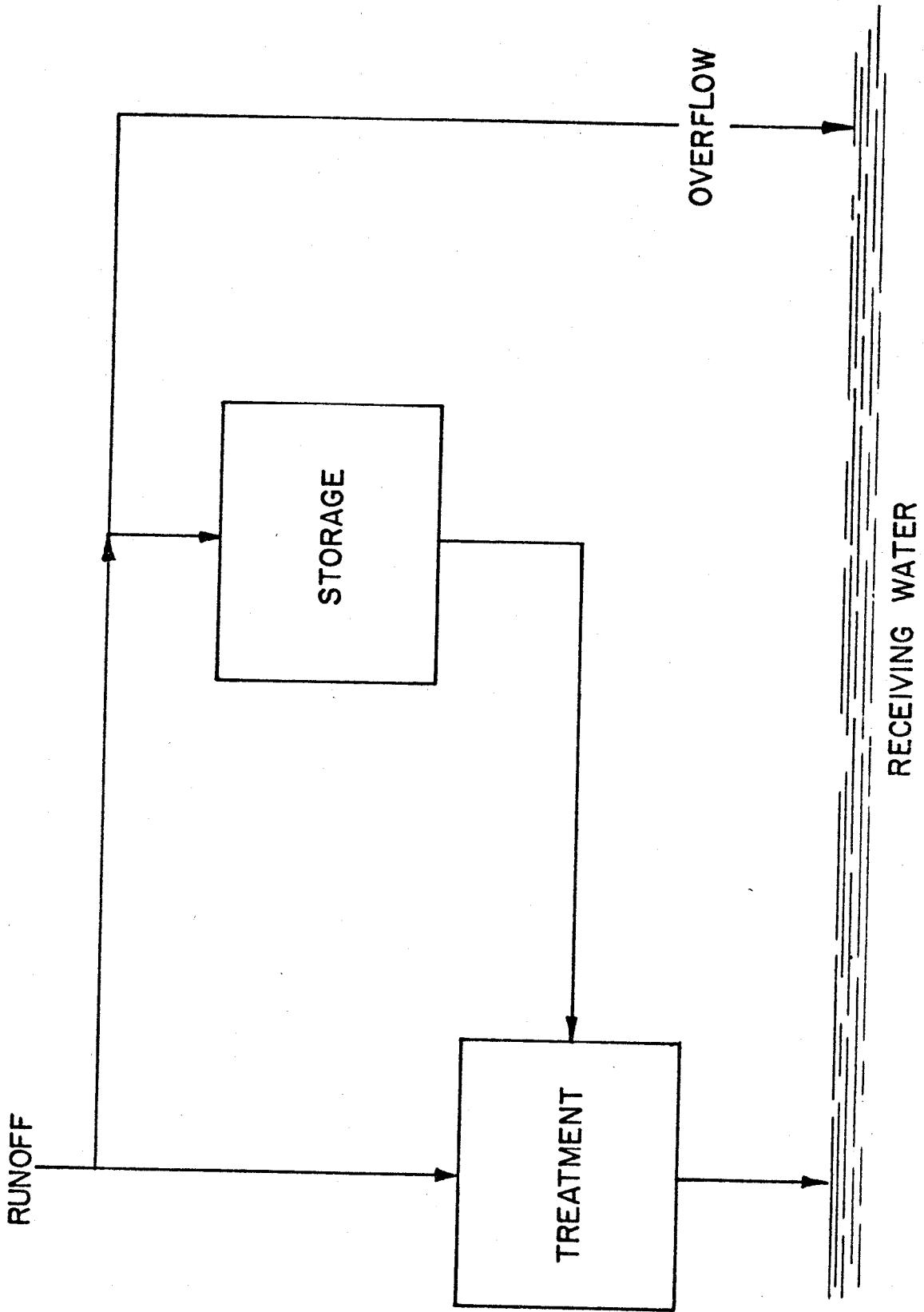


Figure VI-2. Storage-Treatment Configuration Used in STORM Model

Table VI-2. INSTALLED COSTS FOR WET-WEATHER TREATMENT DEVICES

Control Device	Capacity mgd (m ³ /day)	Annual Cost: \$/yr		
		Amortized Capital ^{a,b}	Operation and Maintenance	Total
Swirl Concentrator ^c	6.8 (26,400)	5,600	2,100	7,700
Microstrainer ^d	7.4 (28,700)	14,230	3,895	18,125
Dissolved Air Flotation ^e	25.0 (96,900)	71,706	16,700 ^f	88,406
Contact Stabilization ^g	20.0 (77,500)	120,000	24,000	144,000

^aBased on 8 percent interest for 20 years.

^bConstruction cost. Does not include sludge handling costs.

^cField, 1976.⁷

^dMaher, 1974.⁹

^eLager and Smith, 1974⁵ for Racine, Wisconsin adjusted to ENR = 2200.

^fOperation and maintenance costs based on 480 hours of operation @ \$0.0341/1,000 gallons (\$0.0126 per 1,000 l).

^gAgnew et al., 1975.¹⁰ Operation and maintenance costs based on 960 hours of operation.

Table VI-3. COST FUNCTIONS FOR WET-WEATHER CONTROL DEVICES

Device	Control Alternative	Annual Cost: \$/yr					
		Amortized Capital		Operation and Maintenance		Total	
		CA = $1T^m$		OM = pT^q		$TC = sT^z$	
		or $1S^m$		P	q	or sS^z	
l	m			P	q	S	z
Primary							
	Swirl Concentrator ^{c,d,e}	1,971.0	0.70	493.0	0.70	2,464.0	0.70
	Microstrainer ^{e,f}	7,343.8	0.76	1,836.0	0.76	9,179.8	0.76
	Dissolved Air Flotation	8,161.4	0.84	2,036.7	0.84	10,198.1	0.84
	Sedimentation ^a	32,634.7	0.70	8,157.8	0.70	40,792.5	0.70
Representative Primary Device Total Annual Cost = \$4,000 per mgd ($\$1.05/m^3/day$)							
Secondary							
	Contact Stabilization ^g	19,585.7	0.85	4,894.7	0.85	24,480.4	0.85
	Physical-Chemical ^e	32,634.7	0.85	8,157.8	0.85	40,792.5	0.85
Representative Secondary Device Total Annual Cost = \$15,000 per mgd ($\$3.93/m^3/day$)							
Storage							
	High Density (15 per/ac)	---	---	---	---	51,000.0	1.00
	Low Density (5 per/ac)	---	---	---	---	10,200.0	1.00
	Parking Lot ^h	---	---	---	---	10,200.0	1.00
	Rooftop ^h	---	---	---	---	5,100.0	1.00
Representative Annual Storage Cost ^j (\$ per ac-in) = \$122 e ^{0.16(PD)}							

T^k = Wet-Weather Treatment Rate in mgd; S^l = Storage Volume in mil gal

^aENR = 2200. Includes land costs, chlorination, sludge handling, engineering and contingencies.
^bSludge handling costs based on data from Battelle Northwest, 1974.²³

^cField, 1976.⁷

^dBenjes *et al.*, 1975.¹²

^eLager and Smith, 1974.⁵

^fMaher, 1974.⁹

^gAgnew *et al.*, 1975.¹⁰

^hWiswall and Robbins, 1975.¹³

ⁱFor $T \leq 100$ mgd. No economies of scale beyond 100 mgd ($378.500 m^3/day$).

^jPD = gross population density, persons/acre.

^kOne mgd = $3,785 m^3/day$.

^lOne mil gal = $3,785 m^3$.

Unfortunately, data on the number and flow rate of stormwater discharges in urban areas could not be found. Thus, it is not possible to determine the optimal mix of treatment plants and pipelines. Therefore, the representative treatment costs shown in Table VI-3 were based on using relatively small plant sizes.

Cost data on detention basins built in the Chicago area for temporary storage of runoff are listed in Table VI-4, Capital Cost of Storage Facilities. Costs of storage tanks built for the purpose of wet-weather quantity and quality control as well as for dry-weather quantity control are also included in this table. Due to the wide variations in these figures, an attempt was made to verify these costs using excavation costs as the basis. Storage costs based on unit excavation costs are listed in Table VI-4. The unit cost of equalization and the estimated costs of rooftop and parking lot storage basins for sewage treatment plants are also shown in Table VI-4. Lastly, analysis of recent estimates of storage costs developed by Benjes *et al.* indicates the following unamortized capital cost C ($\$ \times 10^6$) as a function of storage volume, S (mil gal):¹²

<u>Type</u>	<u>Equation</u>	<u>Unit Cost @ S = 10 mil gal \$/gal (\$/liter)</u>
Earthen	$C = 0.025 S^{0.73}$	\$0.013 (\$0.0034)
Concrete w/o Cover	$C = 0.350 S^{0.58}$	\$0.133 (\$0.0350)
Concrete w/ Cover	$C = 0.400 S^{0.79}$	\$0.250 (\$0.0660)

The data indicate wide variation in the costs of storage. Thus, the relatively simple relationship shown in Table VI-3 was used. Annual storage costs are estimated as a function of gross population density. The curve was derived using an unamortized capital cost of \$0.10 per gallon (\$0.026/liter) for PD = 5 persons per acre (12.4/ha) and \$0.50 per gallon (\$0.132/liter) for PD = 15 persons per acre (37.1/ha).

RELATIONSHIP BETWEEN STORAGE/TREATMENT AND PERCENT POLLUTION CONTROL

Use of STORM

STORM was used to evaluate various storage/treatment options for controlling stormwater runoff pollution. This model assumes that the study area can be characterized as a single catchment from which hourly runoff is directed to storage and treatment.

STORM uses a simplified rainfall/runoff relationship, neglects the transport of water through the city and assumes a very simple relationship between storage and treatment. However, these simplifications are essential if one hopes to do a continuous simulation. The continuous simulation approach was used because no general concurrence exists

Table VI-4. CAPITAL COST OF STORAGE FACILITIES^a

	Capacity mill gal (1000 m ³)	Capital Cost \$/gal (\$/liter)	
Storage Reservoirs^b			
Hillside Park	11.4 (43.1)	0.01 (0.003)	Earthen Basin
Heritage Park	36.5 (138.0)	0.01 (0.003)	Earthen Basin
Oak Lawn	7.8 (29.5)	0.02 (0.005)	Earthen Basin
Middle Fork North Branch	195.5 (740.0)	0.02 (0.005)	Earthen Basin
Wilke-Kirchoff	32.6 (123.0)	0.03 (0.008)	Earthen Basin
Melvina Dutch	53.8 (204.0)	0.03 (0.008)	Earthen Basin
Oak Hill Park	25.1 (95.0)	0.02 (0.005)	Earthen Basin
Dolphin Park	<u>53.8 (204.0)</u>	<u>0.01 (0.003)</u>	Earthen Basin
Average	52.1 (197.0)	0.019 (0.005)	
Storage Tanks^e			
Cottage Farm, Boston ^c	1.3 (4.9)	5.21 ^d (1.38)	Covered Conc. Tanks
Spring Creek, New York ^c	10.0 (37.8)	2.33 (0.62)	Covered Conc. Tanks
Chippewa Falls, Wisconsin ^c	2.8 (10.6)	0.29 (0.08)	Asphalt Paved Basin
Humboldt Avenue, Milwaukee ^c	4.0 (15.1)	0.55 (0.14)	Covered Conc. Tanks
Seattle, Washington	32.0 (121.0)	0.25 (0.07)	In-line
Whittier Narrow, Columbus ^c	<u>4.0 (15.1)</u>	<u>1.70 (0.45)</u>	Open Concrete Tanks
Average	9.0 (34.1)	1.72 (0.45)	
Based on Excavation Costs^f			
\$2/cu yd (\$2.62/cu m)		0.01 (0.003)	Earthen Basin
\$5/cu yd (\$6.54/cu m)		0.025 (0.007)	Earthen Basin in Rock
Equalization Basins for Dry Weather Sewage Treatment Plants^g			
	1.0 (3.8)	0.22 (0.06)	Earthen Basin
	3.0 (11.4)	0.10 (0.03)	Earthen Basin
	10.0 (37.8)	0.06 (0.02)	Earthen Basin
	1.0 (3.8)	0.39 (0.10)	Concrete Basin
	3.0 (11.4)	0.28 (0.07)	Concrete Basin
	10.0 (37.8)	0.25 (0.07)	Concrete Basin
Other^h			
Parking Lots		0.10 (0.03)	
Rooftops		0.05 (0.02)	

^aBased on ENR = 2200.

^bSource: Metropolitan Sanitary District of Greater Chicago.

^cAlso used for stormwater treatment.

^dIncludes pumping station, chlorination and outfall facilities.

^eSource: Lager and Smith, 1974.⁵

^fSoil Conservation Service, Gainesville, FL

^gSource: Anon., "Flow Equalization-Plus for Wastewater Treatment Plants?" Civil Engineering, Vol. 45, No. 9, September 1975, pp. 66-68.²¹

^hSource: Wiswall and Robbins, 1975.¹³

regarding an appropriate single event that one should analyze. The degree of control can be expressed in terms of the percent of the runoff treated, the annual number of overflows, or the amount of pollutants discharged to the receiving waters.

As described in the User's Manual, STORM computes the runoff based on the composite runoff coefficient and the effective precipitation.¹⁴ The depression storage must be satisfied before the runoff coefficient is applied to the precipitation. The amount of depression storage available in ditches, depressions, and other surfaces is a function of the past precipitation and the evaporation rates. Each hour that runoff occurs, the model compares it to the treatment rate. As long as the runoff rate is less than or equal to the treatment rate all the runoff passes directly through the treatment plant and storage is not utilized. When the runoff rate exceeds the treatment rate, the excess runoff is sent to storage. If excess runoff occurs frequently enough to exceed the storage capacity then overflow occurs. When runoff falls below the treatment rate then storage is depleted at the excess treatment rate. The hourly occurrence of treated runoff, stored runoff, and runoff that has overflowed is tabulated for the entire record of rainfall. Included in the output is the annual number of overflow events and the percentage of the runoff that overflowed to the receiving waters. This type of analysis was carried out for different storage capacities and treatment rates.

STORM Input Data For Detailed Study of Five Test Cities

STORM requires several input parameters that characterize the urban area under study. These include hourly precipitation, total area, land use types and percentages, percent imperviousness and curb length per area for each land use. Local data used to run STORM on the five study areas were collected by onsite interviews. The main source used by APWA to characterize the urbanized areas was information developed by the National Planning Data Corporation (NPDC) (see Section III). The percent imperviousness and length of street gutters were found by their relationship to population density using Stankowski's equation for imperviousness and APWA's equation for curb length density (Volume III) described in the two previous sections.¹⁵ Daily evaporation rates for each month are from a report by Thornthwaite and Mather.¹⁶ The depression storage is assumed to be 0.01 inches (0.025 cm) for all cities. A summary of input data for all of the study areas is given in Table VI-5, STORM Input Data for Study Areas. The hydrologic data for the study areas are shown in Table VI-6, Hydrologic Data for Study Areas.

Hourly precipitation data were acquired from the US Environmental Data Service in Asheville, North Carolina. Twenty-five years (January 1948 to December 1972) of hourly data were obtained for the five test cities. Two and one-half years (July 1970 to December 1972) of data were obtained for all stations in the United States.

Table VI-5. STORM INPUT DATA FOR STUDY AREAS

Study Area:	Atlanta
Area:	278,400 ac (112,800 ha)
Depression Storage:	0.01 in. (0.025 cm)
Daily evaporation rates for each month, Jan-Dec, in in/day (cm/day)	
0.01 0.02 0.04 0.07 0.10 0.11 0.10 0.08 0.06 0.04 0.02 0.01 (0.03)(0.05)(0.10)(0.18)(0.25)(0.28)(0.25)(0.20)(0.15)(0.10)(0.05)(0.03)	
Study Area:	Denver
Area:	187,500 ac (75,900 ha)
Depression Storage:	0.01 in. (0.025 cm)
Daily evaporation rates for each month, Jan-Dec, in in/day (cm/day)	
0.0 0.0 0.01 0.02 0.04 0.07 0.09 0.08 0.06 0.05 0.03 0.01 (0.0)(0.0)(0.03)(0.05)(0.10)(0.18)(0.23)(0.20)(0.15)(0.13)(0.08)(0.03)	
Study Area:	Minneapolis
Area:	461,400 ac (186,700 ha)
Depression Storage:	0.01 in. (0.025 cm)
Daily evaporation rates for each month, Jan-Dec, in in/day (cm/day)	
0.0 0.0 0.02 0.04 0.06 0.07 0.06 0.05 0.04 0.02 0.0 (0.0)(0.0)(0.05)(0.10)(0.15)(0.18)(0.15)(0.13)(0.10)(0.05)(0.0)	
Study Area:	San Francisco
Area:	435,800 ac (176,400 ha)
Depression Storage:	0.01 in. (0.025 cm)
Daily evaporation rates for each month, Jan-Dec, in in/day (cm/day)	
0.01 0.01 0.01 0.02 0.01 0.02 0.02 0.02 0.02 0.02 0.01 (0.03)(0.03)(0.03)(0.05)(0.03)(0.05)(0.05)(0.05)(0.05)(0.05)(0.03)	
Study Area:	Washington, DC
Area:	316,800 ac (128,200 ha)
Depression Storage:	0.01 in. (0.025 cm)
Daily evaporation rates for each month, Jan-Dec, in in/day (cm/day)	
0.0 0.0 0.01 0.02 0.03 0.05 0.05 0.05 0.03 0.02 0.01 0.0 (0.0)(0.0)(0.03)(0.05)(0.08)(0.13)(0.13)(0.13)(0.08)(0.05)(0.03)(0.0)	

Table VI-6. HYDROLOGIC DATA FOR STUDY AREAS

Study Area	Year	Rainfall in. (cm)	Imperviousness, I/100	Runoff ^a Coefficient, CR	Annual Runoff ^b AR, in. (cm)
Atlanta	1969	44.40 (113.0)	0.299	0.374	16.18 (41.10)
Denver	1960	14.98 (38.0)	0.314	0.386	5.59 (14.20)
Minneapolis	1971	29.29 (74.4)	0.293	0.370	10.50 (26.70)
San Francisco	1967	24.26 (61.6)	0.329	0.397	9.37 (23.80)
Washington, DC	1969	43.30 (110.0)	0.339	0.404	17.22 (43.70)

^aCR = 0.15(100-I)/100 + 0.90 I/100

^bFrom STORM analysis.

The frequency distribution of each of the twenty-five years of rainfall was analyzed for each of the five cities. Little year-to-year variation in the distributions was noted, but there was considerable variation among cities. The annual frequency for twenty-five years of rainfall is shown for the cities in Figure VI-3, Average Twenty-Five Year Rainfall Duration for Each Study Area.

In the early stages of the research it became apparent that multiple runs of STORM would be required on each city to adequately determine the effectiveness of different storage capacities and treatment rates. It was also discovered that making STORM runs using the entire twenty-five years of rainfall for each city was expensive and time consuming.

Since the useful information was in terms of the overall level of control of the runoff, it appeared adequate to run STORM on a single year if the results were the same as running STORM for the entire twenty-five year period. The frequency distributions for the single year chosen for each city are shown in Figure VI-4, Selected One-Year Rainfall Duration for Each Study Area. These may be compared to Figure VI-3 to see how the typical year compares to the twenty-five year average. The monthly distribution for the study year is shown for each study area in Figure VI-5, Monthly Rainfall Distribution for Study Year for Each Study Area. The comparisons indicated that running a single year would be adequate for our purposes.

STORM RESULTS

For each storage/treatment rate combination, there is a value for the percent of the runoff and pollutants which are "treated." By making several runs at different combinations of treatment and storage, points were generated representing different levels of control. Then isoquants were drawn connecting the points that represent combinations of storage capacities and treatment rates which give equivalent percent runoff and/or pollutant "treated." If the concentration of pollutants is constant and "treatment" efficiency, η , is 1.0, then percent runoff control is synonymous with percent pollutant control. Obviously, this is not the case. Thus, account needs to be taken of

1. treatment efficiency, and
2. variable concentration due to first flush effects.

Adjustment for Treatment Efficiency

Let R denote the percent runoff control and η equal treatment plant efficiency. If R_1 denotes the percent pollutant control, then to realize R_1 , one needs to process R_1/η of the runoff. Note that R_1 may be percent BOD removal, percent SS removal, etc. In Table VI-1, representative

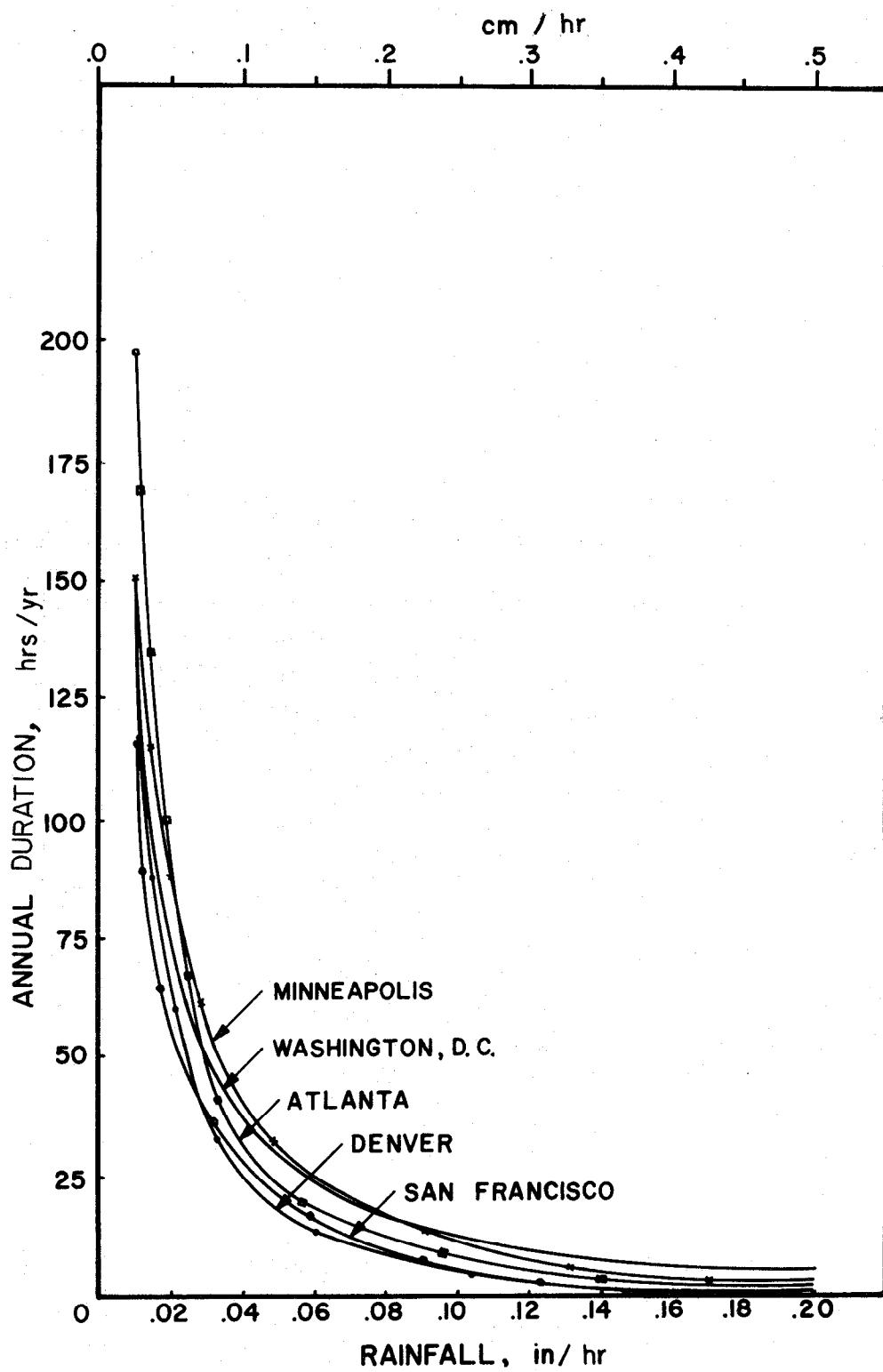


Figure VI-3. Average Twenty-Five Year Rainfall Duration for Each Study Area

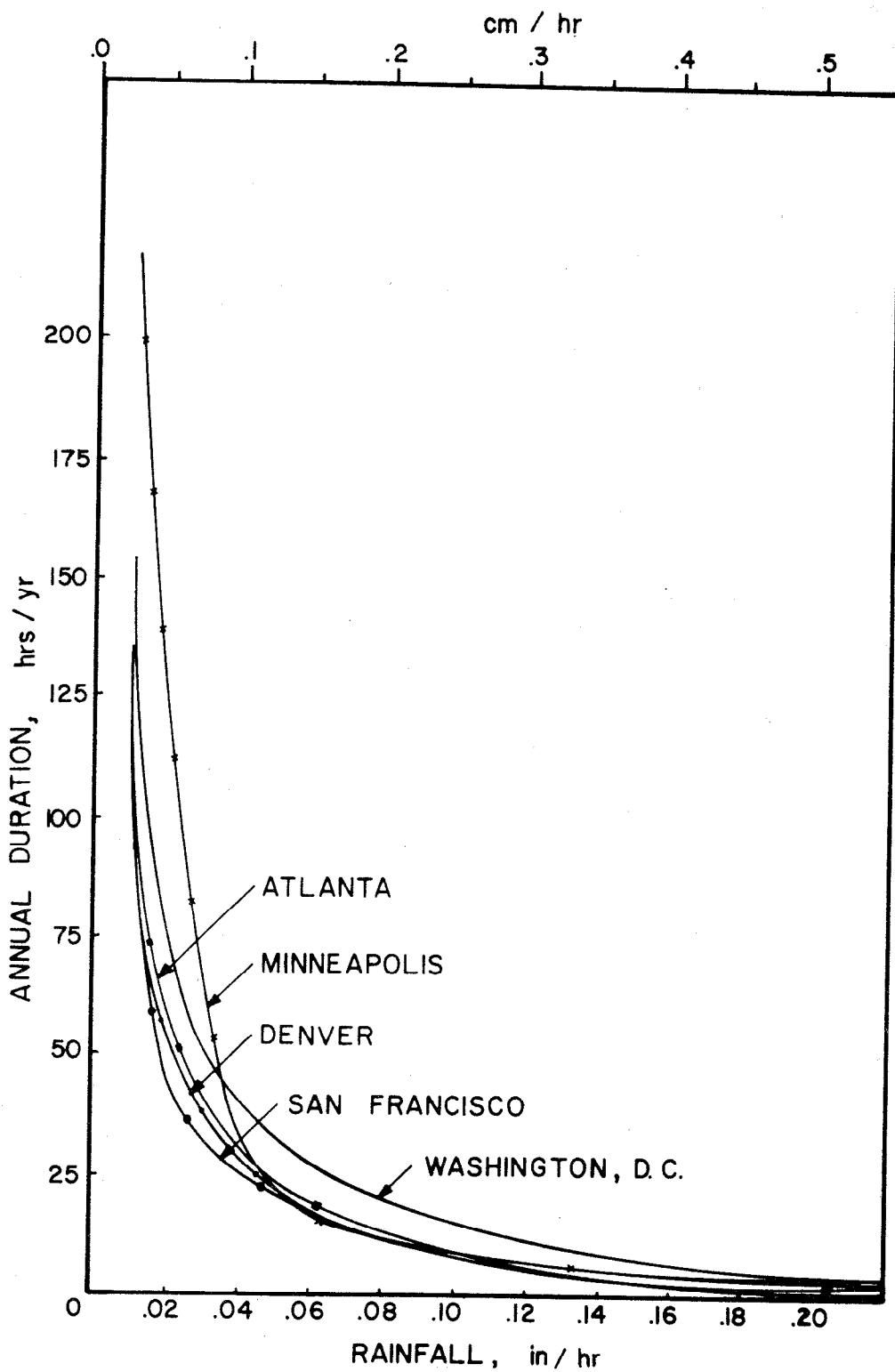


Figure VI-4. Selected One-Year Rainfall Duration for Each Study Area

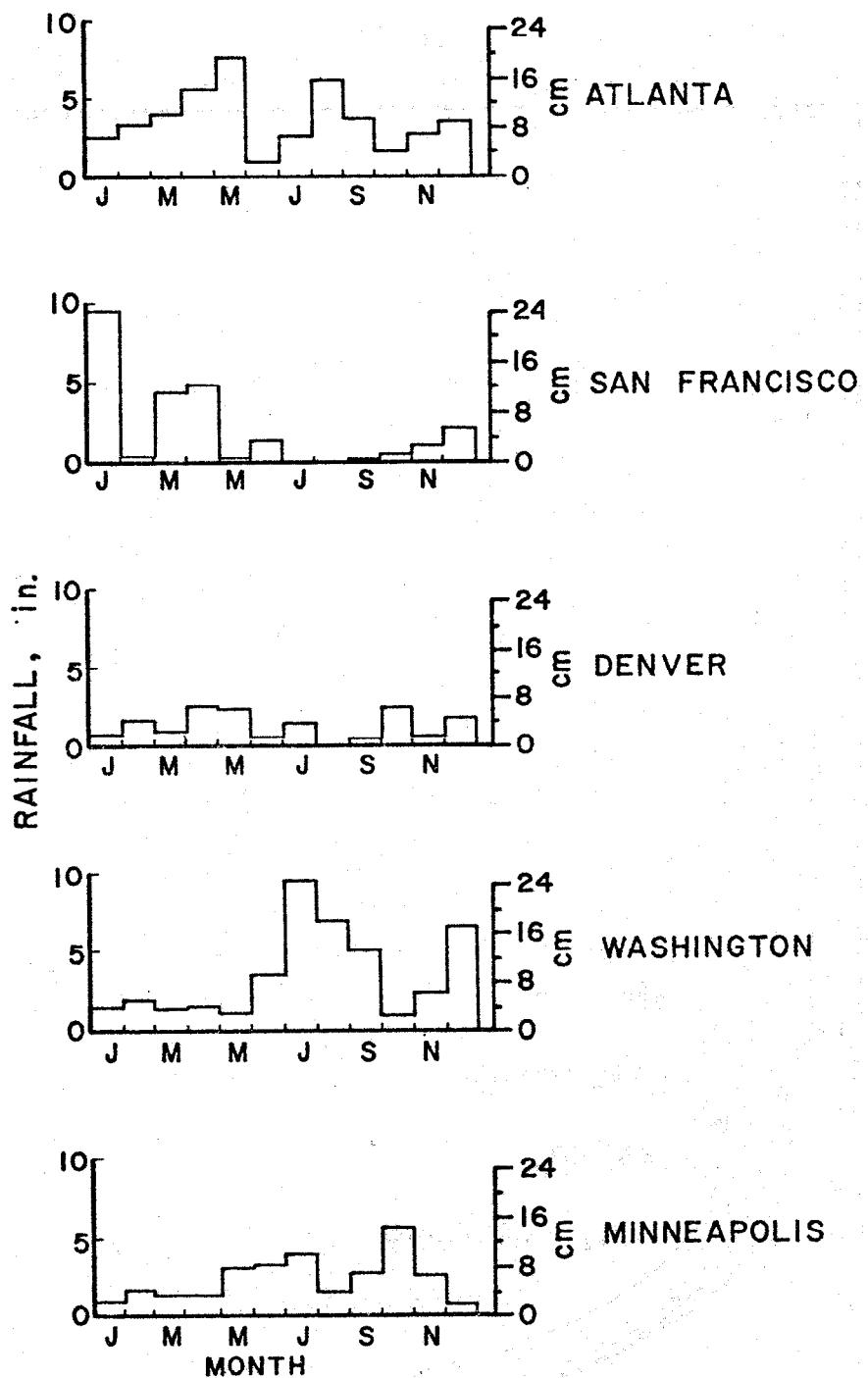


Figure VI-5. Monthly Rainfall Distribution for Study Year for Each Study Area

treatment efficiencies, in terms of BOD_5 removal, were derived for primary and secondary devices. These values are as follows:

Treatment Device	Assumed Efficiency, η (BOD_5 Removal)
Primary	0.40
Secondary	0.85

Thus, if one desires 25 percent BOD_5 removal with a primary device, then 62.5 percent of the runoff volume must be processed whereas only 29.4 percent of the runoff needs to be processed if a secondary device is selected. Thus, to convert percent runoff control isoquants to percent pollutant control isoquants, one uses

$$R = \frac{R_1}{\eta} . \quad 0 \leq R \leq 100 \quad (VI-3)$$

Adjustment for First Flush

STORM estimates the percent pollutant control as well as percent runoff control. The STORM model runs incorporated the standard first flush assumption which is used in the model, i.e., the amount of pollutant removal at any time, t , is proportional to the amount remaining and that a uniform runoff of one-half inch per hour would wash away 90 percent of the pollutant in one hour.¹⁴ If a first flush is assumed, then storage and treatment can be operated more effectively because of the greater relative importance of capturing the initial runoff. The first flush is accounted for by defining the output in terms of pollutant control directly.

Mathematical Representation of Isoquants

The storage/treatment isoquants are of the form:

$$T = T_1 + (T_2 - T_1)e^{-KS} \quad (VI-4)$$

where T = wet-weather treatment rate, inches per hour,

T_1 = treatment rate at which isoquant becomes asymptotic to the ordinate, inches per hour,

T_2 = treatment rate at which isoquant intersects the abscissa, inches per hour,

S = storage volume, inches, and

K = constant, inch⁻¹.

A relatively large storage reservoir is required to operate the treatment unit continuously. Thus, first flush effects would be damped out and the effluent concentration from the reservoir should be relatively uniform. Thus, if stormwater entering the treatment plant has a relatively uniform concentration, then T_1 can be found as follows (using 8,760 hours per year):

$$T_1 = \frac{AR}{8760} \frac{R}{100} = aR \quad (\text{VI-5})$$

where AR = annual runoff, inches per year, and

R = percent runoff control.

By relating the parameters T_1 , $T_2 - T_1$ and K to the level of control R , one equation was developed for each of the five cities. The $T_2 - T_1$ and K terms versus R were found to be of the following general form:

$$T_2 - T_1 = b e^{hR} \quad (\text{VI-6})$$

$$K = d e^{-fR} \quad (\text{VI-7})$$

Based on this analysis the following general equation for the isoquants is obtained:

$$T = aR + b e^{hR - (d e^{-fR}) S} \quad (\text{VI-8})$$

The values of parameters a , b , h , d and f for various cities are presented in Table VI-7, Values of Parameters and Correlation Coefficients for Isoquant Equations for Percent BOD Control Without First Flush and Table VI-8, Values of Parameters and Correlation Coefficients for Isoquant Equations for Percent BOD Control With First Flush. The correlation coefficients for the equations for the four cities are also shown in these tables. In general, the fits are excellent.

The results for the five cities are shown in Figures VI-6, Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region I - San Francisco, VI-7, Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region II - Denver, VI-8, Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region III - Minneapolis, VI-9, Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region IV - Atlanta, and VI-10, Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region V - Washington, DC. Each figure shows the isoquants calculated by the isoquant equation. Also shown are some actual data points for a treatment rate of 0.01 inches per hour and varying amounts of storage.

Table VI-7. VALUES OF PARAMETERS AND CORRELATION COEFFICIENTS FOR ISOQUANT EQUATIONS FOR PERCENT BOD CONTROL WITHOUT FIRST FLUSH

Note: Values are for developed portion of test cities and for $n = 1.0$.

Test City	a $\text{in. hr}^{-1} (\% R)^{-1}$ (cm hr^{-1})	b in. hr^{-1} (cm hr^{-1})	h $(\% R)^{-1}$	d in.^{-1} (cm^{-1})	f $(\% R)^{-1}$	Correlation $T_2 - T_1 = be^{cR}$	Coefficient $K = de^{-fR}$
San Francisco	0.0000107 (0.0000272)	0.0021466 (0.0054524)	0.0377090	108.5330 (275.6738)	0.0335173	0.9821	-0.9888
Denver	0.0000064 (0.0000163)	0.0012194 (0.0030973)	0.0397305	119.8106 (304.3189)	0.0279204	0.9931	-0.9791
Minneapolis	0.0000120 (0.0000305)	0.0012909 (0.0032789)	0.0487845	191.2782 (485.8466)	0.0322136	0.9963	-0.9913
Atlanta	0.0000185 (0.0000470)	0.0022832 (0.0057993)	0.0486532	112.2002 (284.9885)	0.0348027	0.9905	-0.9712
Washington, DC	0.0000197 (0.0000500)	0.0020464 (0.0051979)	0.0567454	117.5456 (298.5650)	0.0398007	0.9925	-0.9759

Table VI-8. VALUES OF PARAMETERS AND CORRELATION COEFFICIENTS FOR ISOQUANT EQUATIONS FOR PERCENT BOD CONTROL WITH FIRST FLUSH

Note: Values are for developed portion of test cities and for $n = 1.0$.

Test City	a $\text{in. hr}^{-1} (\% R)^{-1}$ (cm hr^{-1})	b in. hr^{-1} (cm hr^{-1})	h $(\% R)^{-1}$	d in.^{-1} (cm^{-1})	f $(\% R)^{-1}$	Correlation $T_2 - T_1 = be^{cR}$	Coefficient $K = de^{-fR}$
San Francisco	0.0000107 (0.0000271)	0.0021654 (0.0055001)	0.0388910	211.2763 (536.6418)	0.0320226	0.9893	-0.9898
Denver	0.0000064 (0.0000162)	0.0013631 (0.0034622)	0.0439822	184.9639 (469.8083)	0.0279177	0.9903	-0.9926
Minneapolis	0.0000120 (0.0000304)	0.0013656 (0.0034686)	0.0481981	241.6141 (613.6998)	0.0301648	0.9956	-0.9958
Atlanta	0.0000185 (0.0000469)	0.0025864 (0.0065694)	0.0468175	190.2240 (483.1690)	0.0312484	0.9857	-0.9899
Washington, DC	0.0000197 (0.0000500)	0.0018959 (0.0048155)	0.0487876	228.8434 (581.2622)	0.0339322	0.9933	-0.9896

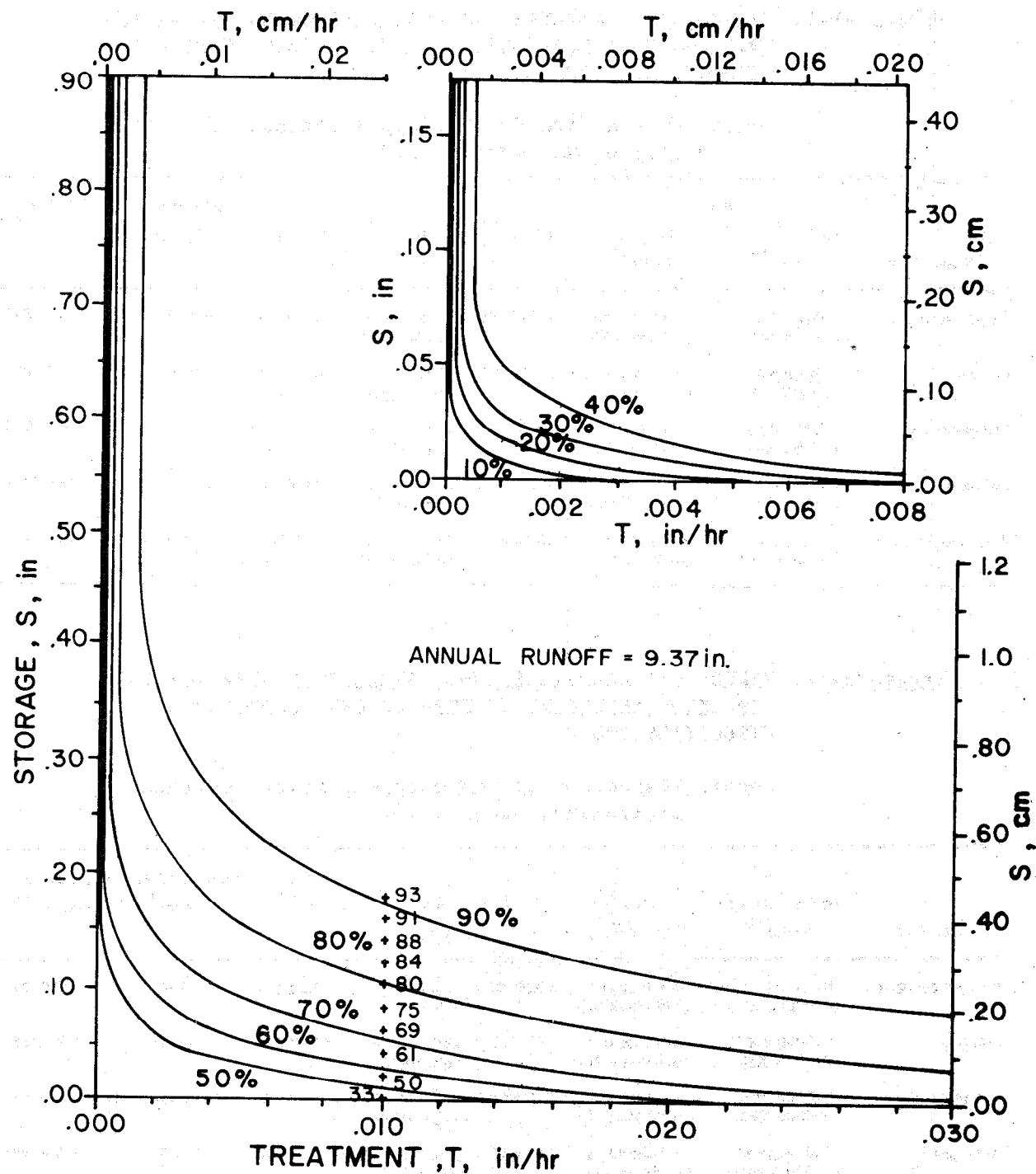


Figure VI-6. Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region I - San Francisco

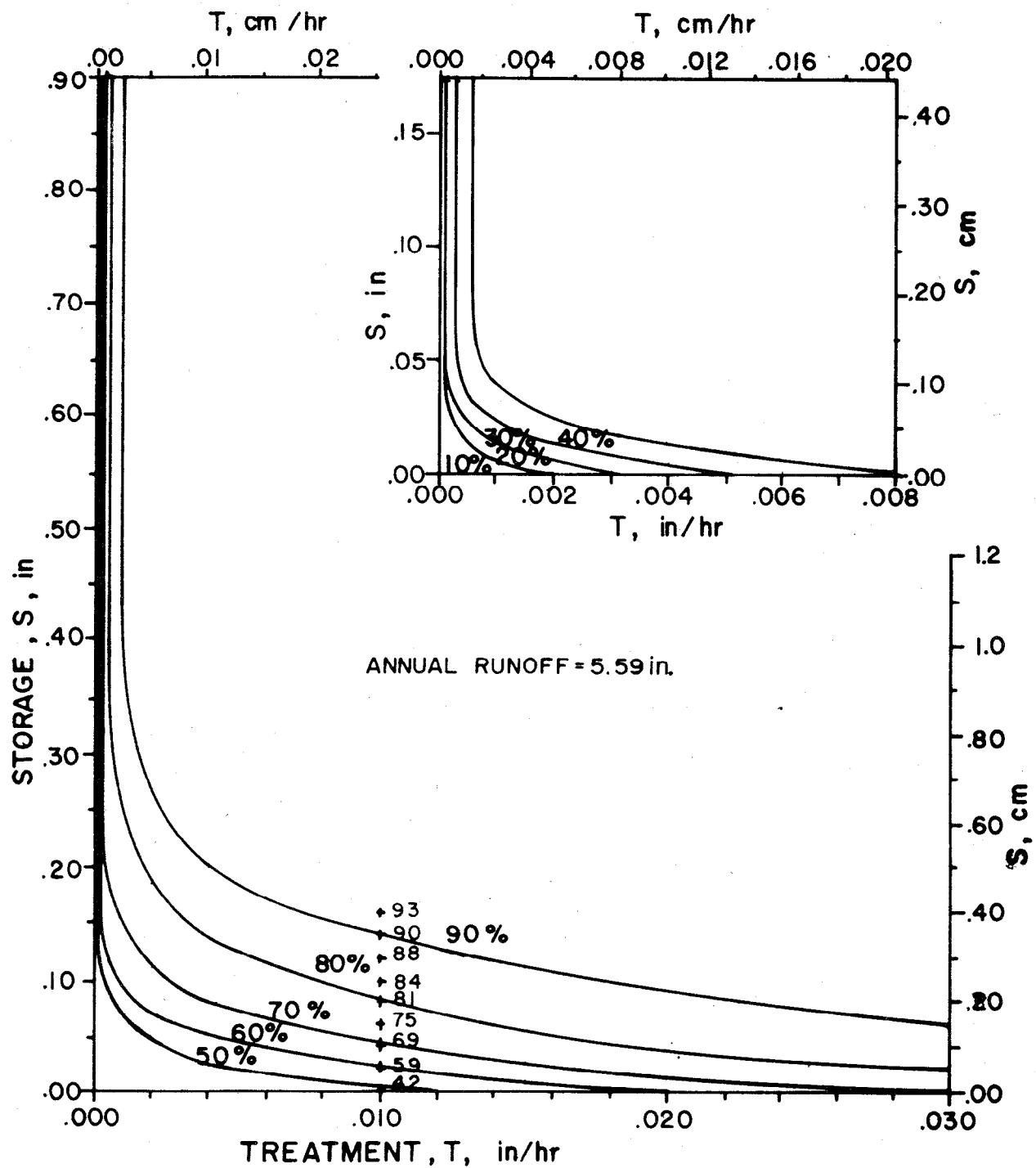


Figure VI-7. Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region II - Denver

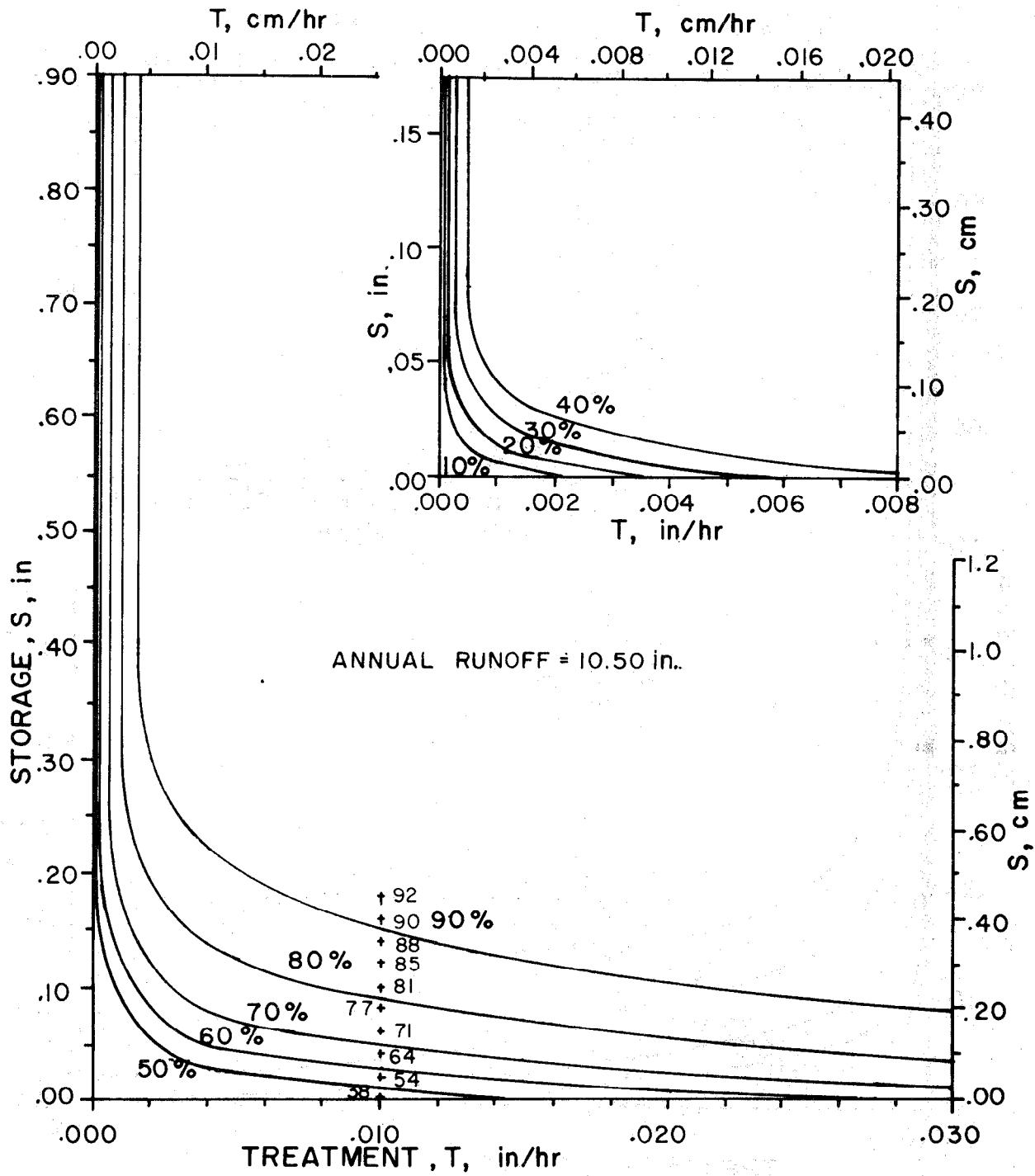


Figure VI-8. Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region III - Minneapolis

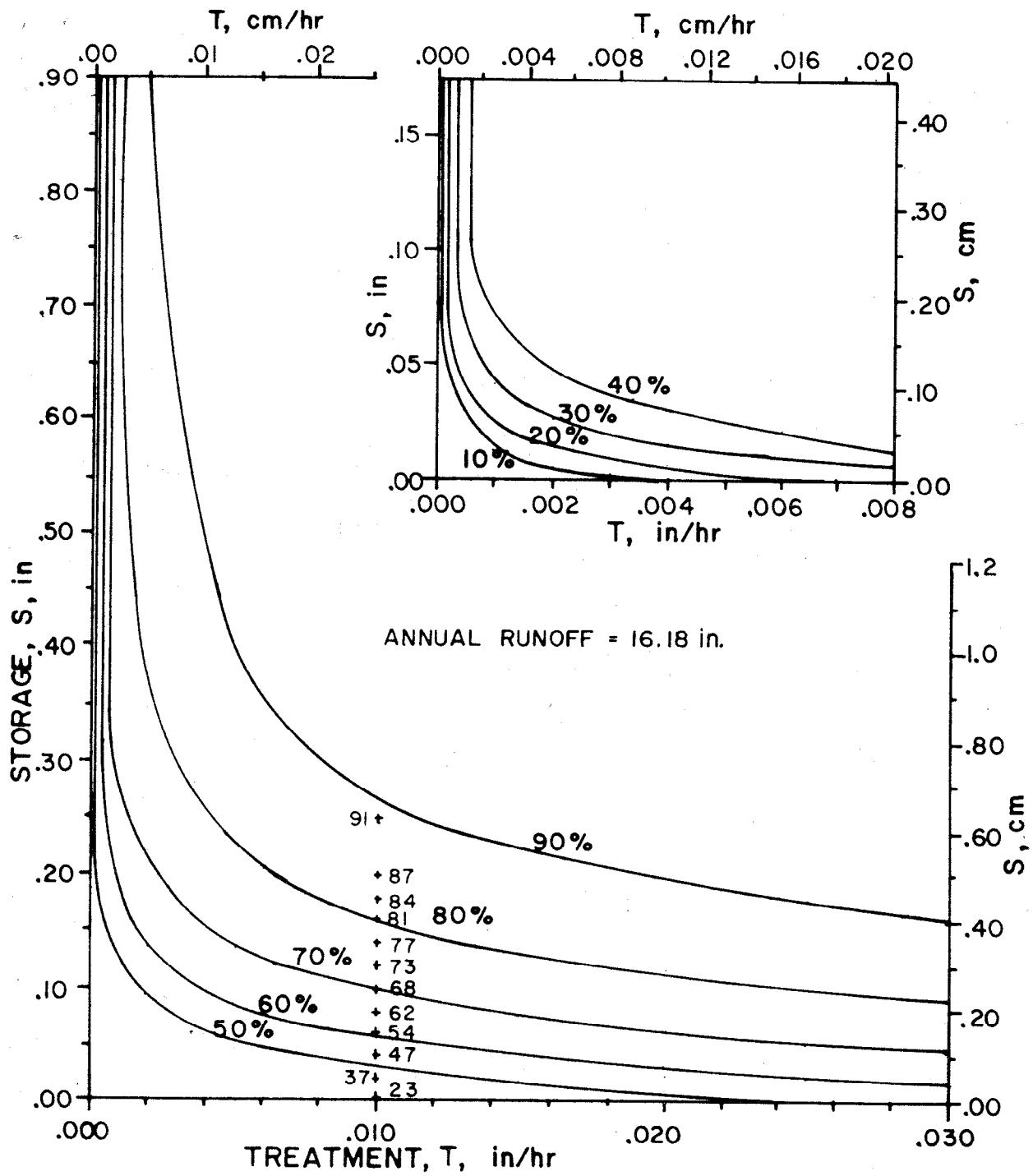


Figure VI-9. Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region IV - Atlanta

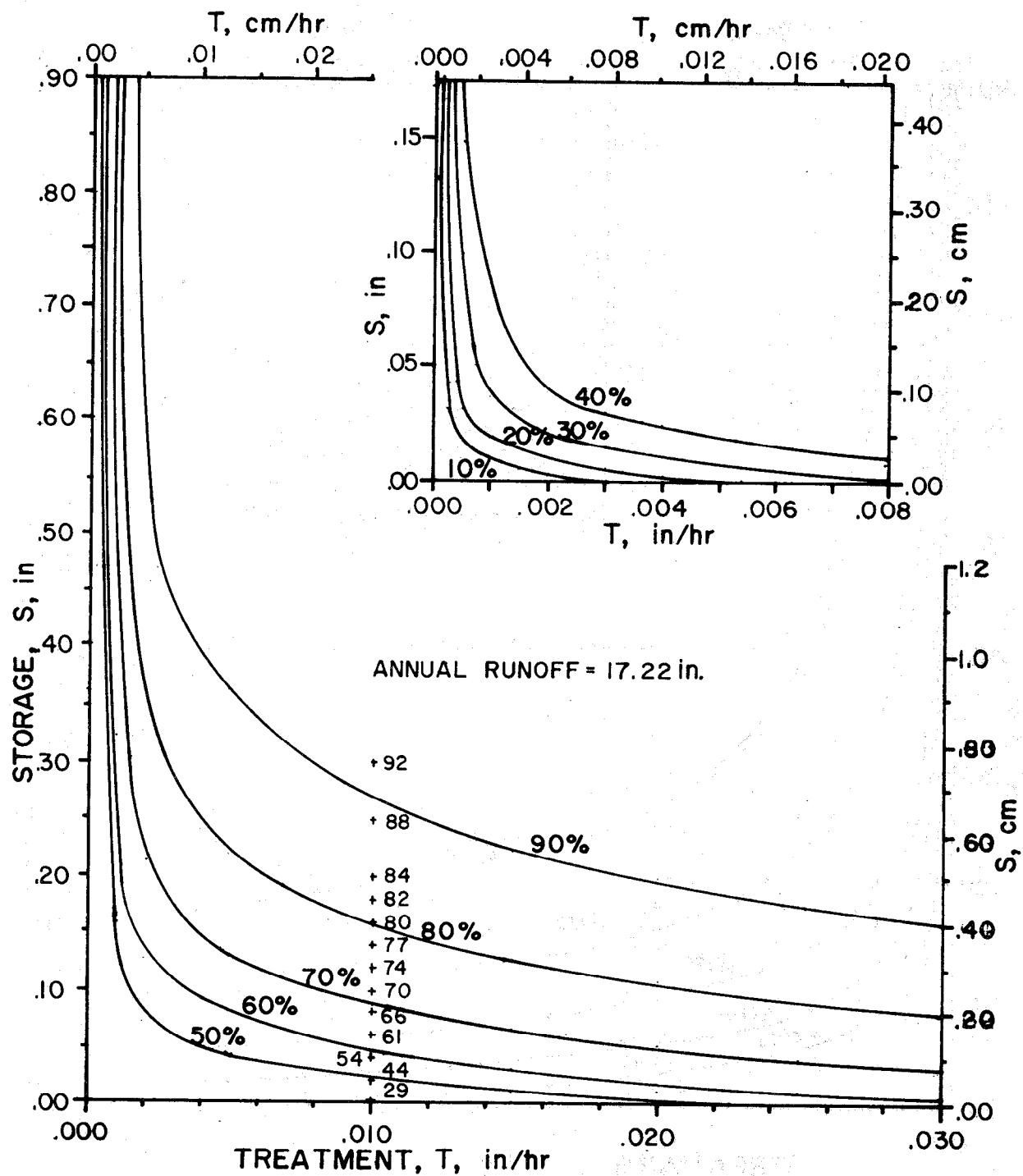


Figure VI-10. Storage-Treatment Isoquants for Percent BOD Removal with First Flush - Region V - Washington, DC

The optimal expansion path can be found using

$$\frac{c_T}{c_S} = MRS_{ST} \quad (VI-9)$$

where c_S = unit cost of storage,

c_T = unit cost of treatment, and

MRS_{ST} = marginal rate of substitution of storage for treatment.

The values of c_S and c_T were presented in Table VI-3.

Analysis of the figures indicates that if $c_T/c_S \leq 25$, then treatment alone should be used. From Table VI-3,

$$\frac{c_T}{c_S} = \frac{c_T}{122 e^{0.16(PD)}} .$$

For primary treatment, $c_T = \$2,610/\frac{\text{acre-inch}}{\text{hour}}$. Thus, even at zero population density, $c_T/c_S = 21.4$ so that the optimal policy is to use treatment only. For secondary treatment, letting $c_T/c_S = 25$ and knowing that $c_T = \$9,800/\frac{\text{acre-inch}}{\text{hour}}$, yields

$$122 e^{0.16(PD)} = \frac{9800}{25}, \text{ or}$$

$$PD = 7.29 \text{ persons/acre.}$$

If PD is higher than about 7.5, then the relative cost of storage is such that it is again optimal to use treatment only. Using 7.5 persons per acre as the cutoff, then some of the 248 cities would use treatment only for the secondary control level. The remaining cities would select a mix of storage and treatment.

It is simple to find the optimal expansion path graphically for the five test cities. Unfortunately, these results need to be extrapolated to the other 243 cities. It appeared that an analytical approach would provide a more general and consistent procedure. Thus, the isoquant parameters were adjusted based on the runoff in the city under consideration relative to the reference city, i.e.,

let AR_i = annual runoff in city i ; $i = 1, 2, \dots, 248$

AR_j = annual runoff in test city for region j ;
 $j = 1, 2, 3, 4, 5$.

Then, the isoquant coefficients are

$$a_{ij} = \frac{AR_i}{(8.76 \times 10^5)} \quad (VI-10)$$

$$b_{ij} = \frac{AR_i}{AR_j} b_j, \quad (VI-11)$$

$$h_{ij} = h_j, \quad (VI-12)$$

$$d_{ij} = \frac{AR_j}{AR_i} d_j, \text{ and} \quad (VI-13)$$

$$f_{ij} = f_j, \quad (VI-14)$$

where a_{ij} , b_{ij} , h_{ij} , d_{ij} , and f_{ij} are parameters for city i in region j and b_j , h_j , d_j , and f_j are the parameters for the test city in region j . The test cities are denoted as follows:

<u>j</u> =	<u>City</u>
1	San Francisco
2	Denver
3	Minneapolis
4	Atlanta
5	Washington, DC.

Wet-Weather Quality Control Optimization

The wet-weather optimization problem, assuming linear costs, may be stated as follows:

minimize

$$Z = c_S S + c_T T \quad (VI-15)$$

subject to

$$T = T_1 + (T_2 - T_1)e^{-KS}$$

$$T, S \geq 0.$$

Solving this constrained optimization problem yields

$$S^* = \max \left[\frac{1}{K} \ln \frac{c_T}{c_S} [K(T_2 - T_1)], 0 \right] \quad (\text{VI-16})$$

where S^* = optimal amount of storage, inches,

and

$$T^* = T_1 + (T_2 - T_1)e^{-KS^*} \quad (\text{VI-17})$$

where T^* = optimal amount of treatment, inches per hour.

Note that T^* is expressed as a function of S^* , so it is necessary to find S^* first. Knowing S^* and T^* , the optimal solution is

$$Z^* = c_S S^* + c_T T^* \quad (\text{VI-18})$$

where Z^* = total annual cost for optimal solution, dollars per acre.

Data needed to estimate T_1 , T_2 and K have already been presented in the previous subsection.

For a primary device, $c_T = \$4,000/\text{mgd} = \$2,610/\frac{\text{acre-inch}}{\text{hour}} = \$1.05/\frac{\text{m}^3}{\text{day}}$.

For storage cost,

$$c_S (\$/\text{acre-inch}) = 122 e^{0.16(\text{PD})} \quad (\text{VI-19})$$

where PD = gross population density in persons per acre.

The above optimization procedure was programmed to generate curves, e.g., Figure VI-11, Control Costs for Primary and Secondary Units in Storm Sewered Areas, Atlanta, showing percent pollutant removed versus total annual costs for primary and secondary treatment in conjunction with storage. Note that, for wet-weather control, marginal costs are increasing because of the disproportionately larger sized control units needed to capture the less frequent larger runoff volumes.

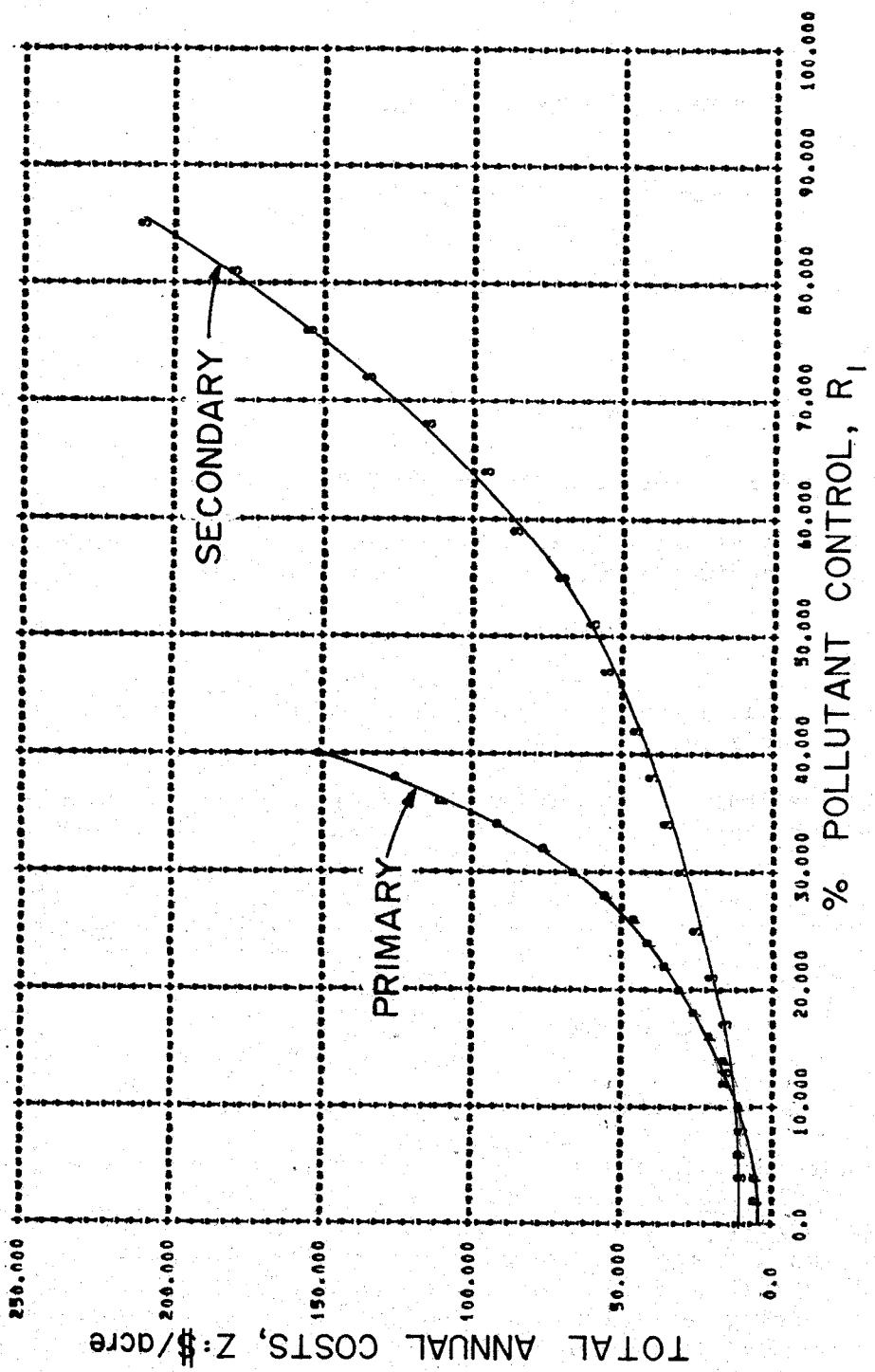


Figure VI-11. Control Costs for Primary and Secondary Units in Storm Sewered Areas, Atlanta

These results also permit one to decide whether a primary or a secondary control level is more cost-effective in controlling smaller percentages of pollution. As seen in Figure VI-11, a primary control device is less expensive for low removals (say \leq 20 percent), but it loses effectiveness at higher levels because of the disproportionately large storage requirements. Costs will be reported for 25, 50, 75, and 85 percent control levels. Thus, the secondary cost curve can be used in this range. The primary curve will not be discussed further.

The curves shown in Figure VI-11 were approximated by functions of the form:

$$Z^* = k e^{\beta R_1} \quad (VI-20)$$

where Z^* = total annual cost for optimal solution, dollars per acre,
 k, β = parameters,

R_1 = percent pollutant removal, $0 \leq R_1 \leq \bar{R}_1$, and

\bar{R}_1 = maximum percent pollutant removal.

The resulting costs for 25, 50, 75, and 85 percent pollutant control for combined, storm, and unsewered areas are shown in Table VI-9, Annual Control Costs - Combined Areas, Table VI-10, Annual Control Costs - Storm Areas, and Table VI-11, Annual Control Costs - Unsewered Areas. The reference city and values of the cost equation parameters are also shown.

Estimating Number of Overflow Events

Some urban areas have used the number of overflow events per year as an indication of level of control due to different storage/treatment combinations. San Francisco, for example, is concerned with the number of times the beaches would be closed due to combined sewer overflows. The objective in this case would be to find the most economical combination of storage and treatment which would not allow the annual number of overflows to exceed a predetermined value. It would not seem logical to increase the treatment rate or storage capacity if the number of overflows did not decrease.

The number of overflow events is affected by the definition of an "event" used in the STORM model wherein an event is defined as starting when storage is utilized and ending when storage is depleted. Even though overflow may take place in two separate time frames, the two occurrences are considered to be parts of the same event if storage is utilized throughout the time frame.

TABLE VI-9 ANNUAL CONTROL COSTS - COMBINED AREAS

EPA REG	STATE ID	URBANIZED AREA	REF CTY	COMBINED AREAS			CONTROL COST (\$/ACRE)
				K	8	25%	
1	CT	BRIDGEPORT	5	0.46	0.043	28.	60.
1	CT	BRISTOL	5	0.0	0.0	0.	233.
1	CT	DANBURY	5	0.0	0.0	0.	0.
1	CT	HARTFORD	5	0.55	0.043	31.	92.
1	CT	MERIDEN	5	0.0	0.0	0.	270.
1	CT	NEW BRITAIN	5	0.0	0.0	0.	0.
1	CT	NEW HAVEN	5	0.61	0.043	28.	81.
1	CT	NORWALK	5	33.20	0.053	136.	561.
1	CT	STAMFORD	5	0.0	0.0	0.	234.
1	CT	WATERBURY	5	10.48	0.043	31.	89.
1	CT	OTHER URBAN AREAS	5	10.56	0.046	33.	102.
1	CT	AVE. FOR STATE	5	10.56	0.046	33.	102.
1	ME	LEWISTON	5	7.42	0.042	21.	60.
1	ME	PORTLAND	5	4.91	0.041	14.	37.
1	ME	OTHER URBAN AREAS	5	5.69	0.041	16.	44.
1	ME	AVE. FOR STATE	5	5.60	0.041	16.	44.
1	MA	BOSTON	5	15.23	0.044	46.	139.
1	MA	BROCKTON	5	0.0	0.0	0.	422.
1	MA	FALL RIVER	5	10.61	0.044	31.	91.
1	MA	FITCHBURG	5	10.21	0.044	30.	86.
1	MA	LAWRENCE	5	6.88	0.042	20.	56.
1	MA	LOWELL	5	11.08	0.045	33.	97.
1	MA	NEW BEDFORD	5	7.92	0.042	23.	65.
1	MA	FITTSFIELD	5	0.0	0.0	0.	188.
1	MA	SPRINGFIELD	5	5.32	0.041	15.	41.
1	MA	WORCESTER	5	17.31	0.045	53.	160.
1	MA	OTHER URBAN AREAS	5	9.20	0.043	27.	79.
1	MA	AVE. FOR STATE	5	9.20	0.043	27.	79.
1	NH	MANCHESTER	5	6.61	0.042	19.	53.
1	NH	NASHUA	5	4.73	0.040	13.	36.
1	NH	OTHER URBAN AREAS	5	5.84	0.041	16.	46.
1	NH	AVE. FOR STATE	5	5.84	0.041	16.	46.
1	RI	PROVIDENCE	5	14.22	0.044	43.	130.
1	RI	OTHER URBAN AREAS	5	14.22	0.044	43.	130.
1	RI	AVE. FOR STATE	5	14.22	0.044	43.	130.
1	VT	URBAN AREAS	5	4.75	0.041	13.	37.
1	VT	AVE. FOR STATE	5	4.75	0.041	13.	37.
1	AVE. FOR REGION 1		5	8.72	0.044	26.	77.
2	NJ	AVE. FOR STATE	5	11.94	0.053	45.	165.
2	NJ	ATLANTIC CITY	5	0.0	0.0	0.	624.
2	NJ	NEW YORK CITY METRO	5	30.97	0.057	127.	524.
2	NJ	PHILADELPHIA METRO	5	6.88	0.042	19.	55.
2	NJ	TRENTON	5	0.0	0.0	0.	156.
2	NJ	VINELAND	5	0.0	0.0	0.	0.
2	NJ	AVE. FOR STATE	5	11.94	0.053	45.	165.
2	NY	ALBANY	5	12.72	0.043	32.	94.
2	NY	BINGHAMPTON	5	5.47	0.041	15.	44.
2	NY	BUFFALO	5	14.30	0.045	44.	134.
2	NY	NEW YORK CITY	5	40.95	0.057	160.	691.
2	NY	ROCHESTER	5	12.78	0.045	39.	2840.
2	NY	SYRACUSE	5	8.18	0.043	24.	120.
2	NY	UTICA	5	9.30	0.043	27.	69.
2	NY	OTHER URBAN AREAS	5	25.81	0.055	103.	404.
2	NY	AVE. FOR STATE	5	25.81	0.055	103.	404.
2	AVE. FOR REGION 2		5	24.45	0.055	97.	381.
2	AVE. FOR REGION 2		5	24.45	0.055	97.	1510.
2	AVE. FOR REGION 2		5	24.45	0.055	97.	2629.

TABLE VI-9 ANNUAL CONTROL COSTS - URBANIZED AREAS

EPA REG	STATE ID	URBANIZED AREA	PFY CITY	FOR PFY-20 DIFES.			CONTROL COST (\$/ACRE)		
				K	B	25%	50%	75%	85%
3	DE	WILMINGTON	5	9.94	0.043	29.	84.	244.	374.
3	DE	OTHER URBAN AREAS	5	9.94	0.043	29.	84.	244.	374.
3	DE	AVE. FOR STATE		9.94	0.043	29.	84.	244.	374.
3	DC	WASHINGTON, D.C.	5	28.97	0.057	119.	490.	2014.	3546.
3	DC	AVE. FOR STATE		28.97	0.057	119.	490.	2014.	3546.
4D	MD	BALTIMORE	5	0.0	0.0	0.	0.	0.	0.
4D	MD	WASHINGTON DC METRO	5	0.0	0.0	0.	0.	0.	0.
4D	MD	OTHER URBAN AREAS	5	0.0	0.0	0.	0.	0.	0.
3	MD	AVE. FOR STATE		0.0	0.0	0.	0.	0.	0.
PA	PA	ALLENTOWN	5	11.51	0.043	34.	100.	294.	453.
PA	PA	ALTOONA	5	8.53	0.042	25.	71.	203.	310.
PA	PA	ERIE	5	7.72	0.042	22.	64.	186.	284.
PA	PA	HARRISBURG	5	10.67	0.043	32.	94.	278.	429.
PA	PA	JOHNSTOWN	5	7.28	0.042	21.	58.	166.	252.
PA	PA	LANCASTER	5	8.14	0.042	23.	67.	193.	294.
PA	PA	PITTSBURGH	5	13.00	0.048	39.	116.	346.	535.
PA	PA	READING	5	12.00	0.048	35.	248.	818.	1317.
PA	PA	SCRANTON	5	10.55	0.041	30.	41.	114.	172.
PA	PA	WILKES-BARRE	5	8.35	0.043	24.	70.	203.	311.
PA	PA	YORK	5	10.00	0.046	44.	141.	447.	711.
PA	PA	OTHER URBAN AREAS	5	14.00	0.046	44.	141.	447.	711.
3	PA	AVE. FOR STATE		14.00	0.046	44.	141.	447.	711.
VA	VA	LYNCHBERG	5	4.15	0.040	11.	31.	85.	127.
VA	VA	NEWPORT NEWS	5	6.00	0.040	16.	50.	130.	190.
VA	VA	NORFOLK	5	6.00	0.040	16.	50.	130.	190.
VA	VA	PETERSBURG	5	6.00	0.040	16.	50.	130.	190.
VA	VA	RICHMOND	5	10.24	0.043	30.	87.	254.	390.
VA	VA	ROANOKE	5	8.08	0.042	23.	67.	192.	293.
VA	VA	WASHINGTON DC METRO	5	14.87	0.044	45.	137.	415.	646.
VA	VA	OTHER URBAN AREAS	5	8.19	0.043	24.	69.	199.	305.
3	VA	AVE. FOR STATE		8.19	0.043	24.	69.	199.	305.
WV	WV	CHARLESTON	5	10.10	0.043	29.	85.	249.	381.
WV	WV	HUNTINGTON	5	5.02	0.041	14.	39.	107.	162.
WV	WV	STEUBENVILLE METRO	5	3.73	0.040	10.	27.	74.	110.
3	WV	WHEELING	5	6.33	0.042	18.	51.	144.	219.
3	WV	OTHER URBAN AREAS	5	6.01	0.042	17.	48.	136.	206.
3	WV	AVE. FOR STATE		6.01	0.042	17.	48.	136.	206.
3	WV	AVE. FOR REGION 3		11.25	0.048	38.	124.	415.	676.

TABLE VI-9 ANNUAL CONTROL COSTS - COMBINED AREAS

EPA REG	STATE ID	URBANIZED AREA	REF CTY	FOR VT-20 CITIES			CONTROL COST (\$/ACRE)		
				K	B	25%	50%	75%	85%
4	AL	BIRMINGHAM	4	0.0	0.0	0.	0.	0.	0.
4	AL	GADSDEN	4	0.0	0.0	0.	0.	0.	0.
4	AL	HUNTSVILLE	4	0.0	0.0	0.	0.	0.	0.
4	AL	MOBILE	4	0.0	0.0	0.	0.	0.	0.
4	AL	MONTGOMERY	4	0.0	0.0	0.	0.	0.	0.
4	AL	TUSCALOOSA	4	0.0	0.0	0.	0.	0.	0.
4	AL	OTHER URBAN AREAS	4	0.0	0.0	0.	0.	0.	0.
4	AL	AVE. FOR STATE	4	0.0	0.0	0.	0.	0.	0.
4	FL	FT LAUDERDALE	4	0.0	0.0	0.	0.	0.	0.
4	FL	GAINESVILLE	4	0.0	0.0	0.	0.	0.	0.
4	FL	JACKSONVILLE	4	0.0	0.0	0.	0.	0.	0.
4	FL	MIAMI	4	0.0	0.0	0.	0.	0.	0.
4	FL	ORLANDO	4	18.99	0.041	53.	146.	406.	610.
4	FL	PENSACOLA	4	0.0	0.0	0.	0.	0.	0.
4	FL	ST. PETERSBURG	4	0.0	0.0	0.	0.	0.	0.
4	FL	TALLAHASSEE	4	0.0	0.0	0.	0.	0.	0.
4	FL	TAMPA	4	0.0	0.0	0.	0.	0.	0.
4	FL	WEST PALM BEACH	4	18.99	0.041	53.	146.	406.	610.
4	FL	OTHER URBAN AREAS	4	0.0	0.0	0.	0.	0.	0.
4	FL	AVE. FOR STATE	4	18.99	0.041	53.	146.	406.	610.
4	GA	ALBANY	4	5.64	0.038	15.	37.	97.	141.
4	GA	ATLANTA	4	11.79	0.040	32.	86.	233.	341.
4	GA	AUGUSTA	4	5.97	0.039	16.	41.	108.	158.
4	GA	COLUMBUS	4	11.63	0.040	31.	84.	228.	338.
4	GA	MACON	4	0.0	0.0	0.	0.	0.	0.
4	GA	SAVANNAH	4	22.76	0.041	64.	180.	505.	762.
4	GA	OTHER URBAN AREAS	4	10.42	0.040	28.	77.	208.	310.
4	GA	AVE. FOR STATE	4	10.42	0.040	28.	77.	208.	310.
4	KY	HUNTINGTON METRO	4	7.48	0.042	21.	61.	176.	269.
4	KY	LEXINGTON	4	0.0	0.0	0.	0.	0.	0.
4	KY	LOUISVILLE	4	11.83	0.044	35.	104.	310.	479.
4	KY	OWENSBORO	4	8.47	0.042	24.	70.	201.	307.
4	KY	OTHER URBAN AREAS	4	9.28	0.043	27.	79.	228.	350.
4	KY	AVE. FOR STATE	4	9.28	0.043	27.	79.	228.	350.
4	MS	BILOXI	4	0.0	0.0	0.	0.	0.	0.
4	MS	JACKSON	4	0.0	0.0	0.	0.	0.	0.
4	MS	OTHER URBAN AREAS	4	0.0	0.0	0.	0.	0.	0.
4	MS	AVE. FOR STATE	4	0.0	0.0	0.	0.	0.	0.
4	NC	ASHEVILLE	4	0.0	0.0	0.	0.	0.	0.
4	NC	CHARLOTTE	4	0.0	0.0	0.	0.	0.	0.
4	NC	DURHAM	4	0.0	0.0	0.	0.	0.	0.
4	NC	FAYETTEVILLE	4	0.0	0.0	0.	0.	0.	0.
4	NC	GREENSBORO	4	0.0	0.0	0.	0.	0.	0.
4	NC	HIGHPOINT	4	0.0	0.0	0.	0.	0.	0.
4	NC	RALEIGH	4	0.0	0.0	0.	0.	0.	0.
4	NC	WILMINGTON	4	0.0	0.0	0.	0.	0.	0.
4	NC	WINSTON-SALEM	4	0.0	0.0	0.	0.	0.	0.
4	NC	OTHER URBAN AREAS	4	0.0	0.0	0.	0.	0.	0.
4	NC	AVE. FOR STATE	4	0.0	0.0	0.	0.	0.	0.
4	SC	CHARLESTON	4	0.0	0.0	0.	0.	0.	0.
4	SC	COLUMBIA	4	0.0	0.0	0.	0.	0.	0.
4	SC	GREENVILLE	4	0.0	0.0	0.	0.	0.	0.
4	SC	OTHER URBAN AREAS	4	0.0	0.0	0.	0.	0.	0.
4	SC	AVE. FOR STATE	4	0.0	0.0	0.	0.	0.	0.
4	TN	CHATTANOOGA	4	13.92	0.040	38.	102.	277.	412.
4	TN	KNOXVILLE	4	0.0	0.0	0.	0.	0.	0.
4	TN	MEMPHIS	4	0.0	0.0	0.	0.	0.	0.
4	TN	NASHVILLE	4	12.68	0.040	35.	94.	256.	383.
4	TN	OTHER URBAN AREAS	4	12.85	0.040	35.	95.	259.	387.
4	TN	AVE. FOR STATE	4	12.85	0.040	35.	95.	259.	387.
4		AVE. FOR REGION	4	10.98	0.040	30.	82.	225.	336.

TABLE VI-C ANNUAL CONTROL COSTS - COMBINED AREAS								
EPA REG	STATE ID	URBANIZED AREA	DEF CTY	CTY	ON VT-20 COEFS.	K	B	25% 50% 75% 85%
5	IL	AURORA	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	IL	BLOOMINGTON	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	IL	CHAMPAIGN	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	IL	CHICAGO	3	26.48	0.047	85	271	867 1380
5	IL	DAVENPORT METRO	3	7.18	0.030	19	51	134 198
5	IL	DECATUR	3	6.19	0.038	16	42	110 162
5	IL	JOLIET	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	IL	KPFOIA	3	5.53	0.038	14	37	97 143
5	IL	ROCKFORD	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	IL	SPRINGFIELD	3	9.10	0.040	25	66	178 264
5	IL	OTHER URBAN AREAS	3	23.86	0.046	76	242	771 1225
5	IL	AVE. FOR STATE		23.86	0.046	76	242	771 1225
5	IN	ANDERSON	3	3.16	0.037	8	20	49 71
5	IN	CHICAGO METRO	3	12.48	0.041	35	96	266 400
5	IN	EVANSVILLE	3	7.67	0.030	20	53	140 205
5	IN	FORT WAYNE	3	3.11	0.041	36	101	281 423
5	IN	INDIANAPOLIS	3	3.98	0.041	39	106	292 438
5	IN	LAFAYETTE	3	14.12	0.041	39	110	307 462
5	IN	MUNCIE	3	8.34	0.036	22	59	156 230
5	IN	SOUTH BEND	3	6.38	0.039	17	44	115 169
5	IN	TERRA HAUTE	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	IN	OTHER URBAN AREAS	3	10.04	0.040	27	75	204 305
5	IN	AVE. FOR STATE		10.04	0.040	27	75	204 305
5	MI	ANN ARBOR	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	MI	BAY CITY	3	4.85	0.039	13	33	87 128
5	MI	DETROIT	3	13.12	0.041	37	103	289 437
5	MI	FLINT	3	8.61	0.040	23	63	172 256
5	MI	GRAND RAPIDS	3	10.83	0.041	30	82	224 340
5	MI	JACKSON	3	16.16	0.039	16	42	111 164
5	MI	KALAMAZOO	3	6.00	0.0	0	0	0.0 0.0 0.0 0.0
5	MI	LANSING	3	8.67	0.040	23	64	172 256
5	MI	MUSKEGON	3	6.00	0.0	0	0	0.0 0.0 0.0 0.0
5	MI	SAGINAW	3	12.05	0.041	34	94	262 366
5	MI	OTHER URBAN AREAS	3	12.05	0.041	34	94	262 366
5	MI	AVE. FOR STATE		12.05	0.041	34	94	262 366
5	MN	DULUTH	3	8.42	0.040	23	62	169 251
5	MN	FARGO METRO	3	4.42	0.039	12	31	83 122
5	MN	MINNEAPOLIS	3	7.72	0.040	21	57	157 234
5	MN	ROCHESTER	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	MN	OTHER URBAN AREAS	3	7.56	0.040	21	56	153 229
5	MN	AVE. FOR STATE		7.56	0.040	21	56	153 229
5	OH	AKRON	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	OH	CANTON	3	17.56	0.042	50	140	397 602
5	OH	CINCINNATI	3	8.00	0.039	21	57	153 226
5	OH	CLEVELAND	3	17.43	0.042	58	145	419 680
5	OH	COLUMBUS	3	17.08	0.042	68	137	390 592
5	OH	DAYTON	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	OH	HAMILTON	3	16.66	0.038	47	130	365 550
5	OH	LIMA	3	14.90	0.038	13	33	85 128
5	OH	LORAIN	3	15.15	0.056	142	578	2342 4099
5	OH	MANSFIELD	3	8.48	0.039	22	60	158 238
5	OH	SPRINGFIELD	3	9.61	0.039	26	69	184 273
5	OH	STEUBENVILLE	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	OH	TOLEDO	3	10.31	0.040	28	77	211 316
5	OH	YOUNGSTOWN	3	12.96	0.040	35	96	263 362
5	OH	OTHER URBAN AREAS	3	11.26	0.041	31	87	242 365
5	OH	AVE. FOR STATE		11.26	0.041	31	87	242 365
5	WI	APPLETON	3	11.40	0.041	32	88	246 371
5	WI	DULUTH METRO	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	WI	GREEN BAY	3	6.44	0.039	17	46	124 183
5	WI	KENOSHA	3	11.95	0.041	33	92	254 382
5	WI	LA CROSSE	3	7.90	0.040	21	57	153 226
5	WI	MADISON	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	WI	MILWAUKEE	3	23.24	0.050	80	277	957 1571
5	WI	OSHKOSH	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	WI	RACINE	3	0.0	0.0	0	0	0.0 0.0 0.0 0.0
5	WI	OTHER URBAN AREAS	3	20.32	0.049	68	235	794 1305
5	WI	AVE. FOR STATE		20.32	0.049	68	235	794 1305
5	WI	AVE. FOR REGION 5		15.06	0.044	46	137	416 650

EPA REG	STATE	URBANIZED AREA	REF #	COMBINED AREAS FOR VT-20 COEFS.			CONTROL COST (\$/ACRE)			85%
				K	B	25%	50%	75%		
6	AR	FORT SMITH	4	5.52	0.038	14	37.	96.	141.	
6	AR	LITTLE ROCK	4	0.0	0.0	0	0.	0.	0.	
6	AR	PINE BLUFF	4	0.0	0.0	0	0.	0.	0.	
6	AR	OTHER URBAN AREAS	5	5.52	0.038	14	37.	96.	141.	
6	AR	AVE. FOR STATE		5.52	0.038	14	37.	96.	141.	
6	LA	BATON ROUGE	4	0.0	0.0	0	0.	0.	0.	
6	LA	LAFAYETTE	4	0.0	0.0	0	0.	0.	0.	
6	LA	LAKE CHARLES	4	0.0	0.0	0	0.	0.	0.	
6	LA	MONROE	4	0.0	0.0	0	0.	0.	0.	
6	LA	NEW ORLEANS	4	0.0	0.0	0	0.	0.	0.	
6	LA	SHREVEPORT	4	0.0	0.0	0	0.	0.	0.	
6	LA	OTHER URBAN AREAS	5	0.0	0.0	0	0.	0.	0.	
6	LA	AVE. FOR STATE		0.0	0.0	0	0.	0.	0.	
6	NM	ALBUQUERQUE	2	0.0	0.0	0	0.	0.	0.	
6	NM	OTHER URBAN AREAS	3	0.0	0.0	0	0.	0.	0.	
6	NM	AVE. FOR STATE		0.0	0.0	0	0.	0.	0.	
6	OK	LAKEPORT	3	0.0	0.0	0	0.	0.	0.	
6	OK	OKLAHOMA CITY	3	0.0	0.0	0	0.	0.	0.	
6	OK	TULSA	3	0.0	0.0	0	0.	0.	0.	
6	OK	OTHER URBAN AREAS	4	0.0	0.0	0	0.	0.	0.	
6	OK	AVE. FOR STATE		0.0	0.0	0	0.	0.	0.	
6	TX	ABILENE	3	0.0	0.0	0	0.	0.	0.	
6	TX	AMARILLO	3	0.0	0.0	0	0.	0.	0.	
6	TX	AUSTIN	3	0.0	0.0	0	0.	0.	0.	
6	TX	BEAUMONT	3	180.62	0.040	51	141.	387.	581.	
6	TX	BROWNSVILLE	3	0.0	0.0	0	0.	0.	0.	
6	TX	BRYAN	3	0.0	0.0	0	0.	0.	0.	
6	TX	CORPUS CHRISTI	3	0.0	0.0	0	0.	0.	0.	
6	TX	DALLAS	3	0.0	0.0	0	0.	0.	0.	
6	TX	EL PASO	3	0.0	0.0	0	0.	0.	0.	
6	TX	FORT WORTH	3	0.0	0.0	0	0.	0.	0.	
6	TX	GALVESTON	3	37.77	0.056	153	621.	2516.	4404.	
6	TX	HARLINGEN	3	0.0	0.0	0	0.	0.	0.	
6	TX	HOUSTON	3	38.00	0.052	140	512.	1877.	3157.	
6	TX	LAREDO	3	0.0	0.0	0	0.	0.	0.	
6	TX	LUBBOCK	3	0.0	0.0	0	0.	0.	0.	
6	TX	MCCALLEN	3	0.0	0.0	0	0.	0.	0.	
6	TX	MIDLAND	3	0.0	0.0	0	0.	0.	0.	
6	TX	ODESSA	3	0.0	0.0	0	0.	0.	0.	
6	TX	PORT ARTHUR	3	0.0	0.0	0	0.	0.	0.	
6	TX	SAN ANGELO	3	0.0	0.0	0	0.	0.	0.	
6	TX	SAN ANTONIO	3	0.0	0.0	0	0.	0.	0.	
6	TX	SHERMAN	3	0.0	0.0	0	0.	0.	0.	
6	TX	TEXARKANA	3	0.0	0.0	0	0.	0.	0.	
6	TX	TEXAS CITY	3	0.0	0.0	0	0.	0.	0.	
6	TX	TYLER	3	0.0	0.0	0	0.	0.	0.	
6	TX	WACO	3	0.0	0.0	0	0.	0.	0.	
6	TX	WICHITA FALL	3	0.0	0.0	0	0.	0.	0.	
6	TX	OTHER URBAN AREAS	4	22.50	0.051	80	277.	992.	1665.	
6	TX	AVE. FOR STATE		22.50	0.051	80	277.	992.	1665.	
6		AVE. FOR REGION 6		10.34	0.048	35	111.	371.	608.	

EPA REG	STATE	URBANIZED AREA	REF CTY	COMBINED AREAS		CONTROL COST (\$/ACRE)	
				ECN VI-20 COEFS.	K B 25%		
7	IA	CEDAR RAPIDS	3	0.0	0.0	0	0
7	IA	DAVENPORT	3	9.61	0.040	26	71
7	IA	DES MOINES	3	9.67	0.056	101	405
7	IA	DUBUQUE	3	0.0	0.0	0	0
7	IA	SIOUX CITY	3	0.0	0.0	0	0
7	IA	WATERLOO	3	0.0	0.0	0	0
7	IA	OTHER URBAN AREAS	3	24.05	0.055	96	385
7	IA	AVE. FOR STATE		24.05	0.055	96	385
7	KS	KANSAS CITY METRO	3	9.53	0.040	26	70
7	KS	TOPEKA	3	9.97	0.040	27	73
7	KS	WICHITA	3	0.0	0.0	0	0
7	KS	OTHER URBAN AREAS	3	9.68	0.040	26	71
7	KS	AVE. FOR STATE		9.68	0.040	26	71
7	MO	COLUMBIA	3	0.0	0.0	0	0
7	MO	KANSAS CITY	3	14.01	0.041	39	109
7	MO	SPRINGFIELD	3	0.0	0.0	0	0
7	MO	ST. JOSEPH	3	3.77	0.037	10	24
7	MO	ST. LOUIS	3	7.69	0.039	20	54
7	MO	OTHER URBAN AREAS	3	8.19	0.039	22	59
7	MO	AVE. FOR STATE		8.19	0.039	22	59
7	NE	LINCOLN	3	0.0	0.0	0	0
7	NE	OMAHA	3	9.98	0.041	28	77
7	NE	OTHER URBAN AREAS	3	9.98	0.041	28	77
7	NE	AVE. FOR STATE		9.98	0.041	28	77
7	NE	AVE. FOR REGION 7		8.80	0.043	26	75
7	NE					224	349
8	CO	BOULDER	2	0.0	0.0	0	0
8	CO	COLORADO SPRINGS	2	0.0	0.0	0	0
8	CO	DENVER	2	19.37	0.051	69	247
8	CO	PUEBLO	2	14.42	0.041	41	114
8	CO	OTHER URBAN AREAS	2	15.04	0.045	46	141
8	CO	AVE. FOR STATE		15.04	0.045	46	141
8	MT	BILLINGS	2	0.0	0.0	0	0
8	MT	GREAT FALLS	2	0.0	0.0	0	0
8	MT	OTHER URBAN AREAS	2	0.0	0.0	0	0
8	MT	AVE. FOR STATE		0.0	0.0	0	0
8	ND	FARGO	3	4.93	0.039	13	35
8	ND	OTHER URBAN AREAS	3	4.93	0.039	13	35
8	ND	AVE. FOR STATE		4.93	0.039	13	35
8	SD	SIOUX FALLS	3	7.36	0.040	20	54
8	SD	OTHER URBAN AREAS	3	7.36	0.040	20	54
8	SD	AVE. FOR STATE		7.36	0.040	20	54
8	UT	OGDEN	2	0.0	0.0	0	0
8	UT	PROVO	2	0.0	0.0	0	0
8	UT	SALT LAKE CITY	2	0.0	0.0	0	0
8	UT	OTHER URBAN AREAS	2	0.0	0.0	0	0
8	UT	AVE. FOR STATE		0.0	0.0	0	0
8	WY	URBAN AREAS	2	0.0	0.0	0	0
8	WY	AVE. FOR STATE		0.0	0.0	0	0
8	WY	AVE. FOR REGION 8		10.72	0.044	32	95
8	WY					286	445

TABLE VT-9 ANNUAL CONTROL COSTS - COMBINED AREAS

EPA REF	STATE ID	URBANIZED AREA	DEF VI-20 COEF.			CONTROL COST (\$/ACRE)			
			CTY	K	B	25%	50%	75%	85%
9	AK	URBAN AREAS		14.83	0.040	40.	107.	287.	426.
9	AK	AVE. FOR STATE		14.83	0.040	40.	107.	287.	426.
9	AZ	PHOENIX	2	0.0	0.0	0.	0.	0.	0.
9	AZ	TUCSON	2	0.0	0.0	0.	0.	0.	0.
9	AZ	OTHER URBAN AREAS	2	0.0	0.0	0.	0.	0.	0.
9	AZ	AVE. FOR STATE		0.0	0.0	0.	0.	0.	0.
9	CA	BAKERSFIELD	1	0.0	0.0	0.	0.	0.	0.
9	CA	FRESNO	1	0.0	0.0	0.	0.	0.	0.
9	CA	LOS ANGELES	1	0.0	0.0	0.	0.	0.	0.
9	CA	MODESTO	1	0.0	0.0	0.	0.	0.	0.
9	CA	OXNARD	1	0.0	0.0	0.	0.	0.	0.
9	CA	SACRAMENTO	1	7.29	0.039	19.	52.	138.	205.
9	CA	SALINAS	1	0.0	0.0	0.	0.	0.	0.
9	CA	SAN BERNARDINO	1	0.0	0.0	0.	0.	0.	0.
9	CA	SAN DIEGO	1	0.0	0.0	0.	0.	0.	0.
9	CA	SAN FRANCISCO	1	27.64	0.045	86.	267.	829.	1304.
9	CA	SAN JOSE	1	0.0	0.0	0.	0.	0.	0.
9	CA	SANTA BARBARA	1	0.0	0.0	0.	0.	0.	0.
9	CA	SANTA ROSA	1	0.0	0.0	0.	0.	0.	0.
9	CA	SEASIDE	1	0.0	0.0	0.	0.	0.	0.
9	CA	STOCKTON	1	0.0	0.0	0.	0.	0.	0.
9	CA	OTHER URBAN AREAS	25.7	0.045	80.	247.	764.	1201.	
9	CA	AVE. FOR STATE		25.7	0.045	80.	247.	764.	1201.
9	HI	HONOLULU	1	0.0	0.0	0.	0.	0.	0.
9	HI	OTHER URBAN AREAS	0.0	0.0	0.0	0.	0.	0.	0.
9	HI	AVE. FOR STATE		0.0	0.0	0.	0.	0.	0.
9	NV	LAS VEGAS	2	0.0	0.0	0.	0.	0.	0.
9	NV	RENU	2	5.22	0.039	14.	36.	96.	142.
9	NV	OTHER URBAN AREAS	5.22	0.039	14.	36.	96.	142.	
9	NV	AVE. FOR STATE		5.22	0.039	14.	36.	96.	142.
9		AVE. FOR REGION 9		24.76	0.045	77.	237.	732.	1150.
10	ID	BOISE	2	0.0	0.0	0.	0.	0.	0.
10	ID	OTHER URBAN AREAS	0.0	0.0	0.0	0.	0.	0.	0.
10	ID	AVE. FOR STATE		0.0	0.0	0.	0.	0.	0.
10	OR	EUGENE	1	14.71	0.039	39.	104.	277.	409.
10	OR	PORLAND	1	18.01	0.039	48.	129.	345.	511.
10	OR	SALEM	1	0.0	0.0	0.	0.	0.	0.
10	OR	OTHER URBAN AREAS	17.94	0.039	48.	128.	343.	509.	
10	OR	AVE. FOR STATE		17.94	0.039	48.	128.	343.	509.
10	WA	SEATTLE	1	14.99	0.039	40.	107.	285.	423.
10	WA	SPOKANE	1	3.69	0.038	10.	25.	65.	96.
10	WA	TACUMA	1	16.08	0.039	43.	114.	305.	451.
10	WA	OTHER URBAN AREAS	11.22	0.039	30.	80.	212.	314.	
10	WA	AVE. FOR STATE		11.22	0.039	30.	80.	212.	314.
10		AVE. FOR REGION 10		13.17	0.039	35.	94.	250.	370.
		AVERAGE FOR THE U.S.		14.05	0.048	47.	151.	501.	815.

TABLE VI-10 ANNUAL CONTROL COSTS - STORM AREAS

EPA REF ID	STATE	URBANIZED AREA	REF CTY	STORM AREAS VI-20 COEFS.			CONTROL COST (\$/ACRE)		
				K	B	25%	50%	75%	85%
1	CT	BRIDGEPORT	1	9.46	0.043	28	80	233	358
1	CT	BRISTOL	1	11.75	0.043	35	103	304	469
1	CT	DANBURY	1	9.07	0.043	26	76	222	339
1	CT	HARTFORD	1	10.65	0.043	31	92	270	416
1	CT	MERIDEN	1	10.39	0.043	34	88	258	395
1	CT	NEW BRITAIN	1	10.35	0.043	24	69	199	303
1	CT	NEW HAVEN	1	9.61	0.043	28	81	234	358
1	CT	NORWALK	1	9.26	0.043	9	23	61	89
1	CT	STAMFORD	1	9.64	0.043	28	81	235	359
1	CT	WATERBURY	1	10.48	0.043	31	89	259	397
1	CT	OTHER URBAN AREAS	1	9.36	0.043	27	79	230	352
1	CT	AVE. FOR STATE	1	9.36	0.043	27	79	230	352
1	ME	LEWISTON	1	0.0	0.0	0	0	0	0
1	ME	PORTLAND	1	0.0	0.0	0	0	0	0
1	ME	OTHER URBAN AREAS	1	0.0	0.0	0	0	0	0
1	ME	AVE. FOR STATE	1	0.0	0.0	0	0	0	0
1	MA	BOSTON	1	15.23	0.044	46	139	422	657
1	MA	BROCKTON	1	10.17	0.043	30	86	251	385
1	MA	FALL RIVER	1	10.61	0.043	31	91	264	406
1	MA	FITCHBURG	1	10.21	0.043	30	86	251	384
1	MA	LAWRENCE	1	10.0	0.043	0	0	0	0
1	MA	LOWELL	1	11.08	0.043	33	97	288	444
1	MA	NEW BEDFORD	1	7.82	0.042	23	65	188	287
1	MA	PITTSFIELD	1	10.35	0.043	30	88	258	396
1	MA	SPRINGFIELD	1	9.0	0.043	30	0	0	0
1	MA	WORCESTER	1	8.62	0.042	25	71	203	310
1	MA	OTHER URBAN AREAS	1	14.01	0.044	42	127	381	592
1	MA	AVE. FOR STATE	1	14.01	0.044	42	127	381	592
1	NH	MANCHESTER	1	0.0	0.0	0	0	0	0
1	NH	NASHUA	1	0.0	0.0	0	0	0	0
1	NH	OTHER URBAN AREAS	1	0.0	0.0	0	0	0	0
1	NH	AVE. FOR STATE	1	0.0	0.0	0	0	0	0
1	RI	PROVIDENCE	1	8.09	0.042	23	67	195	297
1	RI	OTHER URBAN AREAS	1	8.09	0.042	23	67	195	297
1	RI	AVE. FOR STATE	1	8.09	0.042	23	67	195	297
1	VT	URBAN AREAS	1	0.0	0.0	0	0	0	0
1	VT	AVE. FOR STATE	1	0.0	0.0	0	0	0	0
1	VT	AVE. FOR REGION 1	1	12.03	0.044	36	107	318	491
2	NJ	ATLANTIC CITY	1	11.62	0.043	34	102	301	465
2	NJ	NEW YORK CITY METRO	1	14.09	0.044	42	127	382	593
2	NJ	PHILADELPHIA METRO	1	9.0	0.043	0	0	0	0
2	NJ	TRENTON	1	8.09	0.042	23	67	192	293
2	NJ	VINELAND	1	7.87	0.042	22	64	184	279
2	NJ	AVE. FOR STATE	1	13.54	0.044	41	122	364	565
2	NY	ALBANY	1	10.72	0.043	32	94	279	432
2	NY	BINGHAMPTON	1	9.0	0.043	0	0	0	0
2	NY	BUFFALO	1	5.15	0.041	14	41	114	172
2	NY	NEW YORK CITY	1	29.81	0.055	119	471	1908	3322
2	NY	ROCHESTER	1	12.78	0.045	39	120	368	576
2	NY	SYRACUSE	1	8.18	0.043	24	69	200	305
2	NY	UTICA	1	9.30	0.043	27	78	226	346
2	NY	OTHER URBAN AREAS	1	21.90	0.055	86	335	1313	2271
2	NY	AVE. FOR STATE	1	21.90	0.055	86	335	1313	2271
2	NY	AVE. FOR REGION 2	1	16.72	0.051	61	216	786	1323

EPA RFGI	STATE ID	URBANIZED AREA	PEF	STORM AREAS			CONTROL COST (\$/ACRE)		
				CITY	K	B			
3	DE	WILMINGTON	5	9.94	0.043	29.	84.	244.	374.
3	DE	OTHER URBAN AREAS	5	9.94	0.043	29.	84.	244.	374.
3	DE	AVE. FOR STATE	9.94	0.043	29.	84.	244.	374.	
3	DC	WASHINGTON, D.C.	5	11.86	0.044	35.	105.	311.	481.
3	DC	AVE. FOR STATE	11.86	0.044	35.	105.	311.	481.	
3	MD	BALTIMORE	5	10.93	0.043	32.	94.	277.	427.
3	MD	WASHINGTON, DC METRO	5	11.07	0.043	33.	97.	285.	440.
3	MD	OTHER URBAN AREAS	5	10.96	0.043	32.	95.	279.	430.
3	MD	AVE. FOR STATE	10.96	0.043	32.	95.	279.	430.	
3	PA	ALLENTOWN	5	11.51	0.043	34.	100.	294.	453.
3	PA	ALTOONA	5	8.53	0.042	25.	71.	203.	310.
3	PA	ERIE	5	7.13	0.042	26.	59.	168.	257.
3	PA	HARRISBURG	5	10.67	0.043	32.	94.	278.	429.
3	PA	JOHNSTOWN	5	7.28	0.042	24.	58.	166.	252.
3	PA	LANCASTER	5	8.14	0.042	24.	67.	193.	294.
3	PA	PHILADELPHIA	5	10.05	0.043	29.	86.	250.	384.
3	PA	PITTSBURGH	5	22.83	0.048	75.	248.	818.	1317.
3	PA	READING	5	8.10	0.042	23.	67.	192.	294.
3	PA	SCRANTON	5	8.35	0.043	24.	70.	203.	311.
3	PA	WILKES-BARRE	5	7.06	0.042	20.	58.	164.	250.
3	PA	YORK	5	11.15	0.044	34.	101.	305.	474.
3	PA	AVE. FOR STATE	11.15	0.044	34.	101.	305.	474.	
3	VA	LYNCHBERG	5	0.0	0.0	0.	0.	0.	0.
3	VA	NEWPORT NEWS	5	16.68	0.043	31.	91.	267.	409.
3	VA	NORFOLK	5	13.54	0.044	40.	120.	359.	555.
3	VA	PETERSBURG	5	13.29	0.044	40.	119.	354.	549.
3	VA	RICHMOND	5	10.24	0.043	30.	87.	254.	390.
3	VA	ROANOKE	5	8.08	0.042	29.	67.	192.	293.
3	VA	WASHINGTON, DC METRO	5	11.66	0.044	35.	103.	305.	471.
3	VA	OTHER URBAN AREAS	5	11.79	0.043	35.	103.	306.	473.
3	VA	AVE. FOR STATE	11.79	0.043	35.	103.	306.	473.	
3	WV	CHARLESTON	5	10.10	0.043	29.	85.	249.	381.
3	WV	HUNTINGTON	5	8.0	0.0	0.	0.	0.	0.
3	WV	STEUBENVILLE METRO	5	8.0	0.0	0.	0.	0.	0.
3	WV	WHEELING	5	6.33	0.042	18.	51.	144.	219.
3	WV	OTHER URBAN AREAS	5	9.61	0.043	28.	81.	235.	360.
3	WV	AVE. FOR STATE	9.61	0.043	28.	81.	235.	360.	
3	WV	AVE. FOR REGION 3	11.21	0.044	33.	100.	298.	461.	

TABLE VT-10 ANNUAL CONTROL COSTS - STORM AREAS

EPA	STATE	URBANIZED AREA	REF CTY	EGN VI-20 COFFS.	K	B	25%	50%	75%	85%	CONTROL COST (\$/ACRE)
4	AL	BIRMINGHAM	4	13.48	0.040	36	99	267	398	460	445
4	AL	GADSDEN	4	15.26	0.040	42	113	308	302	451	576
4	AL	HUNTSVILLE	4	14.90	0.040	41	111	302	302	450	576
4	AL	MOBILE	4	19.10	0.040	52	142	388	302	450	445
4	AL	MONTGOMERY	4	14.98	0.040	41	111	302	302	450	445
4	AL	TUSCALOOSA	4	10.53	0.039	28	75	198	295	450	445
4	AL	OTHER URBAN AREAS	4	14.92	0.040	40	110	298	295	450	445
4	AL	AVE. FOR STATE		14.92	0.040	40	110	298	298	450	445
4	FL	FT. LAUDERDALE	4	19.12	0.040	53	144	396	593	648	593
4	FL	GAINESVILLE	4	12.49	0.040	34	91	245	364	448	364
4	FL	JACKSONVILLE	4	14.88	0.040	41	110	300	300	453	563
4	FL	MIAMI	4	18.34	0.040	50	137	376	406	610	567
4	FL	ORLANDO	4	18.29	0.041	53	146	380	426	640	567
4	FL	PENSACOLA	4	18.62	0.040	51	139	386	462	548	570
4	FL	ST. PETERSBURG	4	20.03	0.041	55	154	426	548	697	570
4	FL	TALLAHASSEE	4	17.78	0.040	59	134	366	462	523	570
4	FL	TAMPA	4	21.22	0.041	59	166	462	523	697	570
4	FL	WEST PALM BEACH	4	17.37	0.040	47	129	350	380	570	570
4	FL	OTHER URBAN AREAS	4	18.33	0.040	50	138	380	380	570	570
4	FL	AVE. FOR STATE		18.33	0.040	50	138	380	380	570	570
4	GA	ALBANY	4	0.0	0.0	0	0	0	0	0	0
4	GA	ATLANTA	4	11.79	0.040	32	86	233	347	400	347
4	GA	AUGUSTA	4	0.0	0.0	0	0	0	0	0	0
4	GA	COLUMBUS	4	11.63	0.040	31	84	228	338	400	338
4	GA	MACON	4	12.03	0.040	33	89	242	361	422	361
4	GA	SAVANNAH	4	14.98	0.037	13	32	82	119	192	119
4	GA	OTHER URBAN AREAS	4	11.57	0.040	31	84	228	340	400	340
4	GA	AVE. FOR STATE		11.57	0.040	31	84	228	340	400	340
4	KY	HUNTINGTON METRO	5	7.48	0.042	21	61	176	269	321	269
4	KY	LEXINGTON	5	8.78	0.042	25	73	210	321	400	321
4	KY	LOUISVILLE	5	11.83	0.044	35	104	310	479	570	479
4	KY	OWENSBORO	5	8.47	0.042	24	70	201	307	435	307
4	KY	OTHER URBAN AREAS	5	10.97	0.043	32	96	282	435	570	435
4	KY	AVE. FOR STATE		10.97	0.043	32	96	282	435	570	435
4	MS	BTUXI	4	13.68	0.040	37	99	267	397	460	397
4	MS	JACKSON	4	13.63	0.040	37	100	273	407	476	407
4	MS	OTHER URBAN AREAS	4	13.68	0.040	37	100	271	403	476	403
4	MS	AVE. FOR STATE		13.68	0.040	37	100	271	403	476	403
4	NC	ASHEVILLE	4	16.60	0.041	46	127	352	528	596	528
4	NC	CHARLOTTE	4	10.18	0.040	27	74	199	296	371	296
4	NC	DURHAM	4	8.94	0.040	24	64	171	253	331	253
4	NC	FAYETTEVILLE	4	11.35	0.040	31	83	223	331	422	331
4	NC	GREENSBORO	4	12.31	0.039	34	92	251	376	476	376
4	NC	HIGHPOINT	4	8.74	0.039	23	62	164	242	344	242
4	NC	RALEIGH	4	12.58	0.040	34	93	253	377	476	377
4	NC	WILMINGTTON	4	18.98	0.041	53	146	404	607	777	607
4	NC	WINSTON-SALEM	4	11.31	0.040	30	82	222	330	476	330
4	NC	OTHER URBAN AREAS	4	11.69	0.040	32	86	233	348	476	348
4	NC	AVE. FOR STATE		11.69	0.040	32	86	233	348	476	348
4	SC	CHARLESTON	4	11.08	0.040	30	80	216	322	400	322
4	SC	COLUMBIA	4	11.79	0.040	32	86	233	347	424	347
4	SC	GREENVILLE	4	11.11	0.040	30	81	218	324	400	324
4	SC	OTHER URBAN AREAS	4	11.36	0.040	31	83	223	332	400	332
4	SC	AVE. FOR STATE		11.36	0.040	31	83	223	332	400	332
4	TN	CHATTANOOGA	4	13.92	0.040	38	102	277	412	476	412
4	TN	KNOXVILLE	4	11.45	0.040	31	84	226	336	400	336
4	TN	MEMPHIS	4	17.71	0.041	49	136	378	568	648	568
4	TN	NASHVILLE	4	8.88	0.038	24	63	168	248	348	248
4	TN	OTHER URBAN AREAS	4	14.74	0.040	40	111	305	458	558	458
4	TN	AVE. FOR STATE		14.74	0.040	40	111	305	458	558	458
4		AVE. FOR REGION	4	14.58	0.040	40	110	303	454	554	454

EPA REGION	STATE	URBANIZED AREA	DEFF CTY	STORM AREAS			CONTROL COST (\$/ACRE)				
				EON VT-20 COEF'S.		K	B	25%	50%	75%	85%
				1	2						
51	IL	AURORA	3	12.80	0.041	36	68	273	410	392	374
51	IL	BLOOMINGTON	3	12.52	0.041	34	95	261	411	361	311
51	IL	CHAMPAIGN	3	11.80	0.040	32	86	241	390	351	198
51	IL	CHICAGO	3	13.20	0.037	38	20	134	208	178	164
51	IL	DAVENPORT METRO	3	7.16	0.039	19	51	134	178	144	100
51	IL	DECATUR	3	6.00	0.040	30	76	208	302	266	211
51	IL	DOLTON	3	10.00	0.041	28	66	178	243	200	164
51	IL	EDEN PRAIRIE	3	14.05	0.041	39	109	302	455	392	311
51	IL	ELGIN	3	10.00	0.040	25	41	110	164	120	100
51	IL	FOOTMOUNTAIN	3	14.00	0.041	39	109	302	455	392	311
51	IL	GLENDALE	3	10.00	0.040	25	41	110	164	120	100
51	IL	GRANGEVILLE	3	10.00	0.041	25	41	110	164	120	100
51	IL	HARVEY	3	10.00	0.041	25	41	110	164	120	100
51	IL	HOPEWELL	3	10.00	0.041	25	41	110	164	120	100
51	IL	KNOXVILLE	3	10.00	0.041	25	41	110	164	120	100
51	IL	LAWRENCE	3	10.00	0.041	25	41	110	164	120	100
51	IL	MADISON	3	10.00	0.041	25	41	110	164	120	100
51	IL	MARION	3	10.00	0.041	25	41	110	164	120	100
51	IL	MONTGOMERY	3	10.00	0.041	25	41	110	164	120	100
51	IL	MURKIN	3	10.00	0.041	25	41	110	164	120	100
51	IL	NEWTON	3	10.00	0.041	25	41	110	164	120	100
51	IL	PEORIA	3	10.00	0.041	25	41	110	164	120	100
51	IL	ROCKFORD	3	10.00	0.041	25	41	110	164	120	100
51	IL	SPRINGFIELD	3	10.00	0.041	25	41	110	164	120	100
51	IL	OTHER URBAN AREAS	3	10.00	0.041	25	41	110	164	120	100
51	IL	AVE. FOR STATE		5.80	0.039	15	41	110	164	120	100
51	IN	ANDERSON	3	0.00	0.041	0	0	0	0	0	0
51	IN	CHICAGO METRO	3	12.48	0.041	35	96	266	400	340	281
51	IN	EVANSVILLE	3	6.00	0.041	30	0	0	0	0	0
51	IN	FORT WAYNE	3	11.11	0.041	36	101	292	423	388	346
51	IN	INDIANAPOLIS	3	12.98	0.041	39	106	281	423	388	346
51	IN	LAFAYETTE	3	12.17	0.041	35	13	32	46	40	34
51	IN	IMINCIE	3	8.34	0.039	22	59	156	230	200	156
51	IN	SOUTH BEND	3	8.87	0.039	24	63	166	246	200	164
51	IN	TERRA HAUTE	3	8.87	0.039	24	63	166	246	200	164
51	IN	OTHER URBAN AREAS	3	11.63	0.041	32	88	243	364	322	281
51	IN	AVE. FOR STATE		11.63	0.041	32	88	243	364	322	281
51	MI	ANN ARBOR	3	8.01	0.040	22	58	156	232	200	164
51	MI	BAY CITY	3	6.00	0.040	20	0	0	0	0	0
51	MI	DETROIT	3	8.80	0.040	24	65	175	261	227	200
51	MI	FLINT	3	8.63	0.040	23	63	172	256	227	200
51	MI	GRAND RAPIDS	3	10.83	0.041	30	82	227	340	303	256
51	MI	JACKSON	3	10.00	0.040	27	75	203	322	281	240
51	MI	KALAMAZOO	3	10.00	0.040	23	64	172	256	227	200
51	MI	LANSING	3	8.67	0.040	29	79	215	322	281	240
51	MI	MUSKEGON	3	10.46	0.040	29	79	215	322	281	240
51	MI	SAGINAW	3	9.04	0.040	25	67	181	270	232	200
51	MI	OTHER URBAN AREAS	3	9.04	0.040	25	67	181	270	232	200
51	MI	AVE. FOR STATE		9.04	0.040	25	67	181	270	232	200
51	MN	DULUTH	3	8.42	0.040	23	62	169	251	222	183
51	MN	FARGO METRO	3	4.42	0.039	12	31	83	122	100	83
51	MN	MINNEAPOLIS	3	7.72	0.040	21	57	157	234	200	190
51	MN	ROCHESTER	3	6.72	0.039	18	48	128	200	178	155
51	MN	OTHER URBAN AREAS	3	7.66	0.040	21	57	155	232	200	178
51	MN	AVE. FOR STATE		7.66	0.040	21	57	155	232	200	178
51	OH	AKRON	3	13.68	0.041	33	104	288	433	356	326
51	OH	CANTON	3	14.25	0.041	39	109	303	456	389	356
51	OH	CINCINNATTI	3	8.00	0.040	21	57	153	226	200	178
51	OH	CLEVELAND	3	12.43	0.042	50	145	419	640	592	550
51	OH	COLUMBUS	3	17.08	0.042	48	137	390	592	550	516
51	OH	DAYTON	3	11.91	0.040	33	90	247	371	333	300
51	OH	HAMILTON	3	16.66	0.041	47	130	365	550	516	477
51	OH	LIMA	3	6.00	0.040	0	0	0	0	0	0
51	OH	LORAIN	3	10.50	0.040	29	78	212	316	274	247
51	OH	MANSFIELD	3	9.00	0.039	24	63	168	247	200	178
51	OH	SPRINGFIELD	3	9.00	0.039	22	60	158	234	200	178
51	OH	STEUBENVILLE	3	9.00	0.040	25	67	180	269	232	200
51	OH	TOLEDO	3	9.07	0.040	35	86	263	392	351	315
51	OH	YOUNGSTOWN	3	12.96	0.040	40	112	315	477	400	347
51	OH	OTHER URBAN AREAS	3	14.21	0.041	40	112	315	477	400	347
51	OH	AVE. FOR STATE		14.21	0.041	40	112	315	477	400	347
51	WI	APPLETON	3	11.40	0.041	32	88	246	371	322	281
51	WI	DULUTH METRO	3	6.68	0.039	18	48	127	188	153	124
51	WI	GREEN BAY	3	6.44	0.039	17	46	124	183	153	125
51	WI	KENOSHA	3	6.42	0.039	17	45	119	175	148	125
51	WI	LA CROSSE	3	7.90	0.040	21	57	153	288	232	200
51	WI	MADISON	3	11.04	0.041	30	84	232	348	308	268
51	WI	MILWAUKEE	3	5.56	0.038	9	23	60	88	60	48
51	WI	OSHKOSH	3	8.25	0.040	15	41	109	161	121	101
51	WI	RACINE	3	6.77	0.039	15	41	110	162	120	101
51	WI	OTHER URBAN AREAS	3	6.77	0.039	15	41	110	162	120	101
51	WI	AVE. FOR STATE		6.77	0.039	15	41	110	162	120	101
51	WI	AVE. FOR REGION 5		9.10	0.040	25	69	189	283	232	200

TABLE VI-10 ANNUAL CONTROL COSTS - STORM AREAS

EPA REG.	STATE ID	URBANIZED AREA	REF IDCITY	EQU. VT-20 COEFS.		25%	50%	75%	CONTROL COST (\$/ACRE)
				K	B				
6	AR	FORT SMITH	4	0.0	0.0	0	0	0	0
6	AR	LITTLE ROCK	4	13.07	0.040	35	96	264	390
6	AR	PINE BLUFF	4	11.73	0.040	31	85	227	337
6	AR	OTHER URBAN AREAS	12	6.62	0.040	34	92	250	372
6	AR	AVE. FOR STATE		12.62	0.040	34	92	250	372
6	LA	RATON POLICE	4	16.50	0.040	45	122	332	495
6	LA	LAFAYETTE	4	13.25	0.040	36	96	257	381
6	LA	LAKE CHARLES	4	13.92	0.040	38	101	273	406
6	LA	MONTGOMERY	4	10.71	0.039	29	77	206	305
6	LA	NEW ORLEANS	4	13.05	0.043	126	368	1077	1655
6	LA	SHREVEPORT	4	10.65	0.040	29	77	208	310
6	LA	OTHER URBAN AREAS	12	9.87	0.042	86	249	717	1096
6	LA	AVE. FOR STATE		29.87	0.042	86	249	717	1096
6	NM	ALBUQUERQUE	2	5.42	0.038	14	37	95	139
6	NM	OTHER URBAN AREAS	5	4.42	0.038	14	37	95	139
6	NM	AVE. FOR STATE		5.42	0.038	14	37	95	139
6	OK	LAKEPORT	3	5.54	0.039	17	46	123	182
6	OK	OKLAHOMA CITY	3	11.18	0.041	31	85	256	354
6	OK	TULSA	3	15.07	0.040	33	91	248	371
6	OK	OTHER URBAN AREAS	11	11.16	0.040	31	84	252	347
6	OK	AVE. FOR STATE		11.16	0.040	31	84	252	347
6	TX	ABILENE	3	7.05	0.040	19	52	142	212
6	TX	AMARILLO	3	6.53	0.040	18	49	135	202
6	TX	AUSTIN	3	9.23	0.040	25	68	183	272
6	TX	BEAUMONT	3	18.62	0.040	51	141	387	581
6	TX	BROWNSVILLE	3	5.74	0.038	13	40	108	158
6	TX	CARRYAK	3	15.38	0.040	37	101	278	417
6	TX	CORPUS CHRISTI	3	9.84	0.041	27	75	206	310
6	TX	DALLAS	3	12.58	0.041	35	96	265	398
6	TX	EL PASO	3	12.76	0.041	35	96	265	398
6	TX	FORT WORTH	3	10.81	0.041	30	82	228	342
6	TX	GALVESTON	3	10.00	0.040	0	0	0	0
6	TX	HARLINGER	3	4.22	0.038	11	29	75	110
6	TX	HOUSTON	3	11.70	0.040	31	85	227	327
6	TX	LAJERDO	3	11.43	0.039	12	32	85	126
6	TX	LUBBOCK	3	4.43	0.040	12	32	86	127
6	TX	MCALLEN	3	4.47	0.039	12	32	86	127
6	TX	MIDLAND	3	2.80	0.039	7	20	52	124
6	TX	ODESSA	3	3.21	0.039	9	23	61	97
6	TX	PORT ARTHUR	3	12.88	0.039	34	90	246	365
6	TX	SAN ANGELO	3	3.82	0.039	10	27	72	106
6	TX	SAN ANTONIO	3	12.79	0.041	30	83	232	349
6	TX	SHERMAN	3	6.98	0.039	18	48	126	185
6	TX	TEXARKANA	3	9.56	0.040	25	67	178	262
6	TX	TEXAS CITY	3	11.80	0.040	32	86	231	344
6	TX	TYLER	3	11.50	0.040	31	83	223	332
6	TX	WACO	3	2.70	0.040	26	72	196	292
6	TX	WICHITA FALL	3	6.39	0.039	17	45	120	178
6	TX	OTHER URBAN AREAS	10	2.21	0.040	28	76	208	310
6	TX	AVE. FOR STATE		10.21	0.040	28	76	208	310
6		AVE. FOR REGION 6		13.45	0.041	38	105	292	440

TABLE VI		ANNUAL CONTROL COSTS - STORM AREAS		CONTROL COST (\$/ACRE)	
EPA	STATE	URBANIZED AREA	REF	ECN VT-20 CTV	50% 75% 85%
REG	ID			K 1 8	25%
7	IA	CEDAR RAPIDS	3	8.40 0.040	23. 61. 163. 242.
7	IA	DAVENPORT	3	9.61 0.040	26. 71. 191. 285.
7	IA	DES MOINES	3	3.61 0.037	9. 23. 60. 87.
7	IA	DUBUQUE	3	7.10 0.039	19. 50. 133. 197.
7	IA	STOIX CITY	3	8.30 0.040	23. 62. 172. 257.
7	IA	WATERLOO	3	7.54 0.039	20. 55. 147. 217.
7	IA	OTHER URBAN AREAS	3	6.97 0.039	19. 50. 134. 198.
7	IA	AVE. FOR STATE		6.97 0.039	19. 50. 134. 198.
7	KS	KANSAS CITY METRO	3	9.53 0.040	26. 70. 189. 282.
7	KS	TURFKA	3	9.93 0.040	27. 73. 199. 297.
7	KS	KICHTA	3	7.94 0.040	21. 57. 154. 229.
7	KS	OTHER URBAN AREAS	3	8.67 0.040	23. 63. 170. 264.
7	KS	AVE. FOR STATE		8.67 0.040	23. 63. 170. 254.
7	MO	COLUMBIA	3	11.61 0.040	32. 87. 236. 353.
7	MO	KANSAS CITY	3	14.43 0.038	11. 29. 75. 109.
7	MO	SPRINGFIELD	3	11.96 0.040	32. 88. 239. 357.
7	MO	ST. JOSEPH	3	6.00 0.036	0. 0. 0. 0.
7	MO	ST. LOUIS	3	6.00 0.036	0. 0. 0. 0.
7	MO	OTHER URBAN AREAS	3	6.94 0.039	18. 49. 130. 193.
7	MO	AVE. FOR STATE		6.94 0.039	18. 49. 130. 193.
7	NE	LINCOLN	3	8.78 0.040	24. 66. 181. 270.
7	NE	OMAHA	3	9.98 0.041	28. 77. 214. 322.
7	NE	OTHER URBAN AREAS	3	9.24 0.041	25. 70. 194. 290.
7	NE	AVE. FOR STATE		9.24 0.041	25. 70. 194. 290.
7	NE	AVE. FOR REGION	7	7.78 0.040	21. 56. 152. 226.
8	CO	BOULDER	2	12.39 0.038	32. 84. 218. 320.
8	CO	COLORADO SPRINGS	2	6.49 0.038	17. 43. 106. 159.
8	CO	DENVER	2	9.68 0.038	25. 66. 173. 254.
8	CO	PUERTO RICO	2	4.60 0.037	12. 29. 74. 107.
8	CO	OTHER URBAN AREAS	2	9.07 0.038	24. 62. 161. 236.
8	CO	AVE. FOR STATE		9.07 0.038	24. 62. 161. 236.
8	MT	BILLINGS	2	6.46 0.038	17. 42. 108. 157.
8	MT	GREAT FALLS	2	6.40 0.037	16. 41. 104. 152.
8	MT	OTHER URBAN AREAS	2	6.42 0.037	16. 42. 106. 154.
8	MT	AVE. FOR STATE		6.42 0.037	16. 42. 106. 154.
8	ND	FARGO	3	4.93 0.039	13. 35. 94. 140.
8	ND	OTHER URBAN AREAS	3	4.93 0.039	13. 35. 94. 140.
8	ND	AVE. FOR STATE		4.93 0.039	13. 35. 94. 140.
8	SD	STOIX FALLS	3	7.36 0.040	20. 54. 148. 221.
8	SD	OTHER URBAN AREAS	3	7.36 0.040	20. 54. 148. 221.
8	SD	AVE. FOR STATE		7.36 0.040	20. 54. 148. 221.
8	UT	OGDEN	2	10.42 0.038	27. 70. 181. 265.
8	UT	PROVO	2	6.55 0.038	22. 58. 151. 222.
8	UT	SALT LAKE CITY	2	9.40 0.038	24. 63. 164. 241.
8	UT	OTHER URBAN AREAS	2	9.49 0.038	25. 64. 166. 243.
8	UT	AVE. FOR STATE		9.49 0.038	25. 64. 166. 243.
8	WY	URBAN AREAS	2	7.51 0.038	19. 49. 126. 183.
8	WY	AVE. FOR STATE		7.50 0.038	19. 49. 126. 183.
8	WY	AVE. FOR REGION	8	8.29 0.038	22. 56. 147. 216.

TABLE VI-10 ANNUAL CONTROL COSTS - STORM AREAS

EPA REG.	STATE ID	URBANIZED AREA	DEF CTY	FDN VT-20 COEFS.			CONTROL COST (\$/ACRE)		
				K	B	25%	50%	75%	85%
9	AK	URBAN AREAS	1	14.83	0.040	40.	107.	287.	426.
9	AK	AVE. FOR STATE		14.83	0.040	40.	107.	287.	426.
9	AZ	PHOENIX	2	4.93	0.038	10.	27.	70.	103.
9	AZ	TUCSON	2	5.69	0.038	15.	38.	96.	140.
9	AZ	OTHER URBAN AREAS		4.45	0.038	11.	30.	77.	112.
9	AZ	AVE. FOR STATE		4.45	0.038	11.	30.	77.	112.
9	CA	BAKERSFIELD	1	4.85	0.039	13.	35.	93.	138.
9	CA	FRESNO	1	3.93	0.039	10.	28.	74.	109.
9	CA	LOS ANGELES	1	5.35	0.039	14.	38.	102.	151.
9	CA	MODESTO	1	3.11	0.039	12.	38.	104.	154.
9	CA	DYNAARD	1	6.67	0.039	18.	48.	128.	190.
9	CA	SACRAMENTO	1	7.20	0.039	19.	52.	138.	205.
9	CA	SALINAS	1	4.99	0.039	13.	35.	93.	137.
9	CA	SAN PERMANENTE	1	9.15	0.039	25.	66.	178.	265.
9	CA	SAN DIEGO	1	4.77	0.039	13.	34.	91.	136.
9	CA	SAN FRANCISCO	1	10.08	0.039	27.	72.	193.	287.
9	CA	SAN JOSE	1	7.25	0.040	20.	53.	142.	214.
9	CA	SANTA BARBARA	1	6.09	0.039	16.	43.	113.	167.
9	CA	SANTA ROSA	1	8.37	0.039	22.	57.	150.	221.
9	CA	SEASIDE	1	8.57	0.039	11.	29.	77.	114.
9	CA	STMT VALLEY	1	8.25	0.039	23.	58.	153.	225.
9	CA	STOCKTON	1	4.68	0.039	12.	33.	87.	128.
9	CA	OTHER URBAN AREAS		6.02	0.039	16.	43.	115.	170.
9	CA	AVE. FOR STATE		6.02	0.039	16.	43.	115.	170.
9	HI	HONOLULU	1	10.97	0.039	29.	79.	212.	314.
9	HI	OTHER URBAN AREAS		10.97	0.039	29.	79.	212.	314.
9	HI	AVE. FOR STATE		10.97	0.039	29.	79.	212.	314.
9	NV	LAS VEGAS	2	2.24	0.038	6.	15.	39.	58.
9	NV	RENU	2	3.05	0.037	8.	20.	50.	73.
9	NV	OTHER URBAN AREAS		2.38	0.038	6.	16.	41.	60.
9	NV	AVE. FOR STATE		2.38	0.038	6.	16.	41.	60.
9	NV	AVE. FOR REGION 9		6.06	0.039	16.	43.	115.	171.
10	ID	BOISE	2	4.94	0.037	13.	32.	82.	119.
10	ID	OTHER URBAN AREAS		4.94	0.037	13.	32.	82.	119.
10	ID	AVE. FOR STATE		4.94	0.037	13.	32.	82.	119.
10	OR	EUGENE	1	14.71	0.039	39.	104.	277.	409.
10	OR	PORTLAND	1	18.91	0.039	48.	129.	365.	511.
10	OR	SALEM	1	13.48	0.039	36.	94.	249.	367.
10	OR	OTHER URBAN AREAS		16.65	0.039	44.	119.	317.	469.
10	OR	AVE. FOR STATE		16.65	0.039	44.	119.	317.	469.
10	WA	SEATTLE	1	14.99	0.039	40.	107.	285.	423.
10	WA	SPOKANE	1	0.0	0.0	0.	0.	0.	0.
10	WA	TACOMA	1	16.08	0.039	43.	114.	305.	451.
10	WA	OTHER URBAN AREAS		15.37	0.039	41.	109.	292.	432.
10	WA	AVE. FOR STATE		15.37	0.039	41.	109.	292.	432.
10	WA	AVE. FOR REGION 10		14.12	0.039	38.	100.	266.	394.
		AVERAGE FOR THE U.S.		10.82	0.043	32.	94.	279.	434.

EPA REG	STATE ID	URBANIZED AREA	DEF CTY	UNSEWFRED EON VI-20 COEFS. K	AREAS 25% 50% 75% 85%	CONTROL COST (\$/ACRE)			
						50%	75%	85%	
1	CT	BRIDGEPORT		0.039	9.	23.	61.	91.	
1	CT	BRISTOL		0.039	7.	19.	51.	75.	
1	CT	DANBURY		0.039	8.	20.	54.	78.	
1	CT	HARTFORD		0.039	8.	21.	56.	86.	
1	CT	MERIDEN		0.039	8.	21.	56.	82.	
1	CT	NEW BRITAIN		0.040	10.	22.	52.	107.	
1	CT	NEW HAVEN		0.039	10.	22.	50.	103.	
1	CT	NORWALK		0.039	10.	22.	50.	89.	
1	CT	STAMFORD		0.039	10.	22.	50.	101.	
1	CT	WATERBURY		0.039	9.	21.	56.	98.	
1	CT	OTHER URBAN AREAS		0.039	9.	21.	52.	92.	
1	CT	AVE. FOR STATE		3.31	0.039	9.	23.	62.	
1	ME	LEWISTON		2.74	0.038	7.	19.	49.	
1	ME	PORTLAND		4.91	0.041	14.	37.	102.	
1	ME	OTHER URBAN AREAS		3.68	0.040	10.	27.	72.	
1	ME	AVE. FOR STATE		3.68	0.040	10.	27.	72.	
1	MA	BOSTON		0.82	0.039	7.	19.	51.	
1	MA	BROCKTON		0.49	0.039	9.	22.	66.	
1	MA	FALL RIVER		0.45	0.039	9.	22.	65.	
1	MA	FITCHBURG		0.16	0.039	8.	22.	56.	
1	MA	LAWRENCE		0.70	0.040	10.	27.	73.	
1	MA	LOWELL		0.79	0.039	7.	19.	51.	
1	MA	NEW BEDFORD		0.55	0.040	10.	26.	69.	
1	MA	PITTSFIELD		0.98	0.039	8.	21.	54.	
1	MA	SPRINGFIELD		0.32	0.041	15.	41.	79.	
1	MA	WORCESTER		0.78	0.041	10.	27.	112.	
1	MA	OTHER URBAN AREAS		3.32	0.039	9.	24.	63.	
1	MA	AVE. FOR STATE		3.32	0.039	9.	24.	63.	
1	NH	MANCHESTER		3.16	0.039	8.	22.	60.	
1	NH	NASHUA		4.73	0.040	13.	36.	98.	
1	NH	OTHER URBAN AREAS		3.80	0.040	10.	28.	76.	
1	NH	AVE. FOR STATE		3.80	0.040	10.	28.	76.	
1	RI	PROVIDENCE		2.85	0.039	8.	20.	52.	
1	RI	OTHER URBAN AREAS		2.85	0.039	8.	20.	52.	
1	RI	AVE. FOR STATE		2.85	0.039	8.	20.	52.	
1	VT	URBAN AREAS		4.11	0.041	11.	31.	87.	
1	VT	AVE. FOR STATE		4.11	0.041	11.	31.	87.	
1	VT	AVE. FOR REGION 1		3.33	0.039	9.	24.	63.	
2	NJ	ATLANTIC CITY		2.75	0.039	7.	19.	50.	
2	NJ	NEW YORK CITY METRO		0.72	0.038	7.	19.	48.	
2	NJ	PHILADELPHIA METRO		0.6	0.037	5.	13.	34.	
2	NJ	TRENTON		0.65	0.040	10.	26.	50.	
2	NJ	VINELAND		3.22	0.039	9.	23.	71.	
2	NJ	AVE. FOR STATE		2.74	0.038	7.	19.	49.	
2	NY	ALBANY		0.63	0.039	7.	18.	49.	
2	NY	BINGHAMPTON		0.14	0.040	8.	20.	61.	
2	NY	BUFFALO		0.81	0.039	7.	20.	54.	
2	NY	NEW YORK CITY		0.00	0.00	0.	14.	90.	
2	NY	ROCHESTER		0.05	0.038	5.	14.	37.	
2	NY	SYRACUSE		0.09	0.039	8.	20.	54.	
2	NY	UTICA		0.09	0.039	9.	20.	59.	
2	NY	OTHER URBAN AREAS		0.09	0.039	7.	19.	67.	
2	NY	AVE. FOR STATE		2.69	0.039	7.	19.	50.	
2	NY	AVE. FOR REGION 2		2.73	0.039	7.	19.	49.	

EPA REG	STATE ID	URBANIZED AREA	REF CTY	UNSEWERED COEFS. K	EON VI-20 6	AREAS	CONTROL COST (\$/ACRE)		
							25%	50%	75%
3	DE	WILMINGTON	5	3.60	0.039	10.	26.	68.	85.
3	DE	OTHER URBAN AREAS		3.60	0.039	10.	26.	68.	101.
3	DE	AVE. FOR STATE		3.60	0.039	10.	26.	68.	101.
3	DC	WASHINGTON, D.C.	5	0.0	0.0	0.	0.	0.	0.
3	DC	AVE. FOR STATE		0.0	0.0	0.	0.	0.	0.
3	MD	BALTIMORE	5	3.37	0.039	9.	24.	64.	94.
3	MD	WASHINGTON DC METRO	5	3.02	0.039	8.	21.	56.	83.
3	MD	OTHER URBAN AREAS		3.25	0.039	9.	23.	61.	90.
3	MD	AVE. FOR STATE		3.25	0.039	9.	23.	61.	90.
3	PA	ALLENTOWN	5	3.26	0.039	9.	23.	61.	89.
3	PA	ALTOONA	5	3.81	0.040	10.	28.	74.	110.
3	PA	ERIE	5	3.28	0.039	9.	24.	64.	95.
3	PA	HARRISBURG	5	3.65	0.039	7.	18.	48.	71.
3	PA	JOHNSTOWN	5	3.50	0.040	12.	33.	91.	135.
3	PA	LANCASTER	5	3.78	0.040	10.	27.	74.	110.
3	PA	PHILADELPHIA	5	3.50	0.039	10.	25.	67.	100.
3	PA	PITTSBURGH	5	3.95	0.039	5.	13.	43.	68.
3	PA	READING	5	3.64	0.040	10.	26.	71.	105.
3	PA	SCRANTON	5	3.52	0.040	9.	26.	69.	103.
3	PA	WILKES-BARRE	5	3.11	0.039	8.	22.	59.	88.
3	PA	YORK	5	3.70	0.040	10.	27.	73.	109.
3	PA	OTHER URBAN AREAS		2.71	0.039	10.	19.	50.	73.
3	PA	AVE. FOR STATE		2.71	0.039	7.	19.	50.	73.
3	VA	LYNCHBERG	5	0.0	0.0	0.	0.	0.	0.
3	VA	NEWPORT NEWS	5	3.21	0.039	8.	22.	59.	87.
3	VA	NORFOLK	5	3.90	0.038	8.	20.	52.	76.
3	VA	PETERSBURG	5	3.77	0.038	7.	19.	50.	73.
3	VA	RICHMOND	5	3.22	0.038	9.	24.	64.	94.
3	VA	ROANOKE	5	3.39	0.039	9.	24.	64.	94.
3	VA	WASHINGTON DC METRO	5	3.65	0.040	10.	26.	71.	105.
3	VA	OTHER URBAN AREAS		3.13	0.039	8.	22.	57.	85.
3	VA	AVE. FOR STATE		3.13	0.039	8.	22.	57.	85.
3	WV	CHARLESTON	5	3.46	0.039	9.	24.	65.	96.
3	WV	HUNTINGTON	5	3.00	0.0	0.	0.	0.	0.
3	WV	STEUBENVILLE METRO	5	3.00	0.0	0.	0.	0.	0.
3	WV	WHEELING	5	3.89	0.040	11.	29.	78.	117.
3	WV	OTHER URBAN AREAS		3.57	0.039	10.	26.	68.	101.
3	WV	AVE. FOR STATE		3.57	0.039	10.	26.	68.	101.
3		AVE. FOR REGION 3		2.94	0.039	8.	21.	55.	81.

EPA REG	STATE ID	URBANIZED AREA	REF CTY	UNSEWERED AREAS EON VI-20		CONTROL COST (\$/ACRE)		
				K	B	25%	50%	75%
4	AL	BIRMINGHAM	4	5.34	0.037	14.	35.	89.
4	AL	GADSDEN	4	4.49	0.037	11.	28.	71.
4	AL	HUNTSVILLE	4	4.07	0.037	10.	26.	64.
4	AL	MOBILE	4	5.88	0.037	15.	37.	95.
4	AL	MONTGOMERY	4	5.12	0.037	14.	33.	84.
4	AL	TUSCALOOSA	4	6.61	0.038	17.	44.	114.
4	AL	OTHER URBAN AREAS	4	5.33	0.037	14.	34.	87.
4	AL	AVE. FOR STATE	4	5.33	0.037	14.	34.	87.
4	FL	FT. LAUDERDALE	4	5.28	0.037	13.	34.	85.
4	FL	GAINESVILLE	4	5.52	0.038	14.	36.	92.
4	FL	JACKSONVILLE	4	4.26	0.037	11.	27.	67.
4	FL	MIAMI	4	5.68	0.037	14.	37.	93.
4	FL	ORLANDO	4	5.98	0.037	10.	25.	63.
4	FL	PENSACOLA	4	5.71	0.037	14.	37.	93.
4	FL	ST. PETERSBURG	4	4.56	0.037	11.	29.	73.
4	FL	TALLAHASSEE	4	5.00	0.037	13.	32.	81.
4	FL	TAMPA	4	4.03	0.037	10.	25.	65.
4	FL	WEST PALM BEACH	4	5.72	0.037	15.	37.	93.
4	FL	OTHER URBAN AREAS	4	5.87	0.037	12.	31.	78.
4	FL	AVE. FOR STATE	4	4.87	0.037	12.	31.	78.
4	GA	ALBANY	4	4.80	0.038	10.	20.	52.
4	GA	ATLANTA	4	4.90	0.038	13.	32.	82.
4	GA	AUGUSTA	4	5.97	0.039	16.	41.	108.
4	GA	COLUMBUS	4	5.19	0.038	13.	34.	87.
4	GA	MACON	4	4.17	0.037	11.	27.	68.
4	GA	SAVANNAH	4	4.69	0.037	12.	30.	76.
4	GA	OTHER URBAN AREAS	4	4.95	0.038	13.	32.	83.
4	GA	AVE. FOR STATE	4	4.95	0.038	13.	32.	83.
4	KY	HUNTINGTON METRO	5	3.56	0.040	10.	26.	70.
4	KY	LEXINGTON	5	3.77	0.040	10.	27.	73.
4	KY	LOUISVILLE	5	2.89	0.039	8.	20.	53.
4	KY	OWENSBORO	5	3.84	0.040	10.	28.	75.
4	KY	OTHER URBAN AREAS	5	3.04	0.039	8.	21.	57.
4	KY	AVE. FOR STATE	5	3.04	0.039	8.	21.	57.
4	MS	BILOXI	4	6.18	0.038	16.	40.	104.
4	MS	JACKSON	4	4.81	0.037	12.	32.	81.
4	MS	OTHER URBAN AREAS	4	5.49	0.037	14.	36.	91.
4	MS	AVE. FOR STATE	4	5.49	0.037	14.	36.	91.
4	NC	ASHEVILLE	4	3.73	0.037	9.	23.	59.
4	NC	CHARLOTTE	4	4.59	0.038	12.	30.	77.
4	NC	DURHAM	4	5.27	0.038	14.	35.	91.
4	NC	FAYETTEVILLE	4	4.93	0.038	13.	32.	82.
4	NC	GREENSBORO	4	3.78	0.038	10.	30.	61.
4	NC	HIGHPOINT	4	5.76	0.038	15.	39.	100.
4	NC	RALEIGH	4	4.64	0.038	12.	30.	77.
4	NC	WILMINGTON	4	3.98	0.038	10.	25.	63.
4	NC	WINSTON-SALEM	4	4.94	0.038	14.	35.	83.
4	NC	OTHER URBAN AREAS	4	4.69	0.038	12.	31.	78.
4	NC	AVE. FOR STATE	4	4.69	0.038	12.	31.	78.
4	SC	CHARLESTON	4	5.06	0.038	13.	33.	85.
4	SC	COLUMBIA	4	4.83	0.038	14.	32.	83.
4	SC	GREENVILLE	4	4.82	0.038	14.	32.	83.
4	SC	OTHER URBAN AREAS	4	4.96	0.038	13.	32.	83.
4	SC	AVE. FOR STATE	4	4.96	0.038	13.	32.	83.
4	TN	CHATTANOOGA	4	5.26	0.037	13.	34.	87.
4	TN	KNOXVILLE	4	4.77	0.038	12.	31.	80.
4	TN	MEMPHIS	4	4.00	0.038	10.	26.	64.
4	TN	NASHVILLE	4	3.72	0.037	10.	24.	59.
4	TN	OTHER URBAN AREAS	4	4.22	0.037	11.	27.	68.
4	TN	AVE. FOR STATE	4	4.22	0.037	11.	27.	68.
4	TN	AVE. FOR REGION	4	4.74	0.037	12.	31.	78.
								114.